NASA

Aeronautical Engineering
A Continuing Bibliography with Indexes

NASA SP-7037(203)
August 1986

National Aeronautics and
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NASA SP-7037(203)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 203)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in July 1986 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

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Washington, DC

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INTRODUCTION

This issue of *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 449 reports, journal articles, and other documents originally announced in June 1986 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes -- subject, personal author, corporate source, foreign technology, contract number, report number, and accession number -- are included.

An annual cumulative index will be published.

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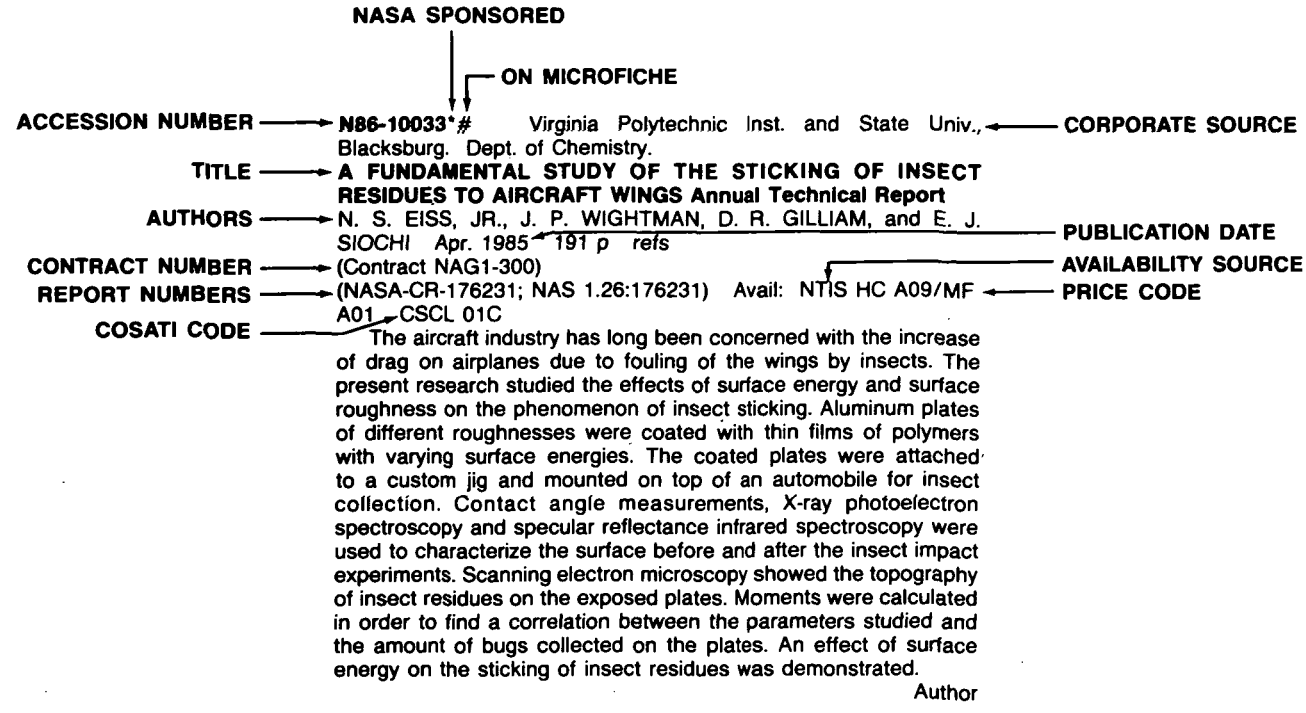
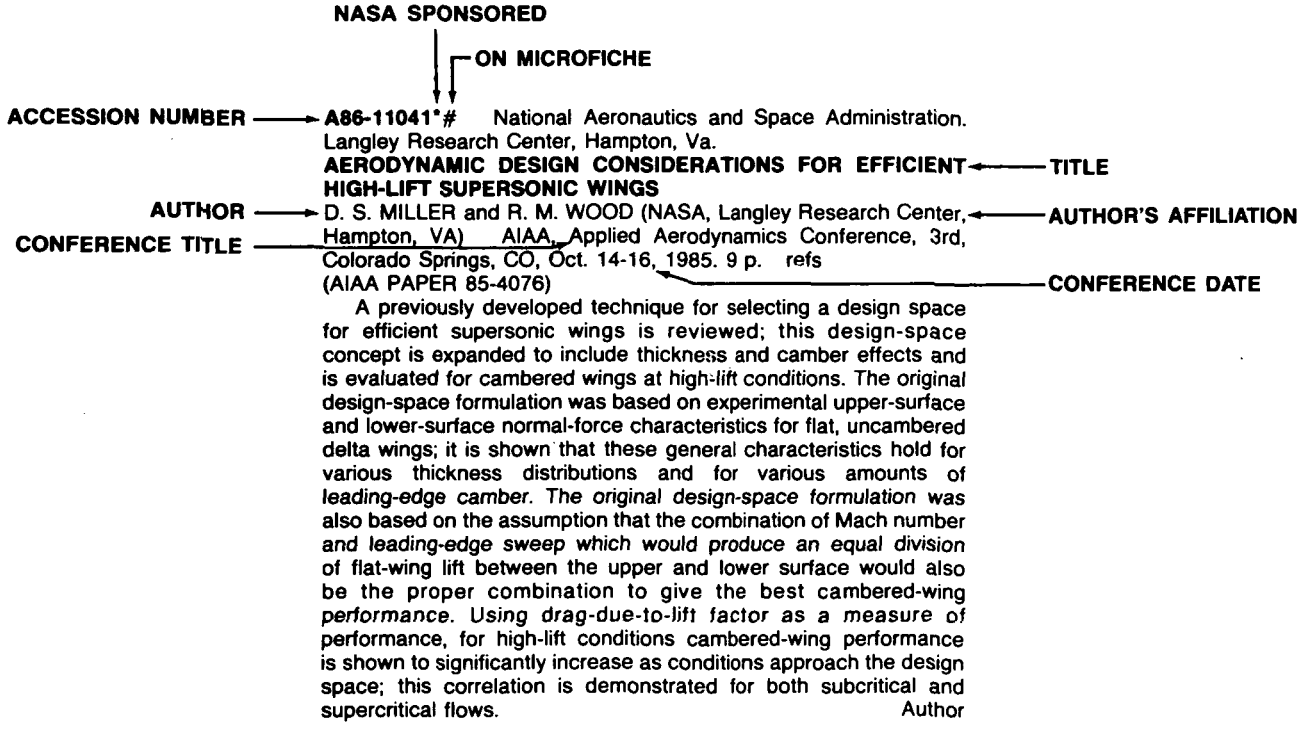
TYPICAL REPORT CITATION AND ABSTRACT



TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 203)

AUGUST 1986

01

AERONAUTICS (GENERAL)

A86-29868#
THE HISTORY OF INSTRUMENT FLIGHT
W. R. ERCOLINE (USAF, Instrument Flight Center, Randolph AFB, TX) IN: Symposium on Aviation Psychology, 3rd, Columbus, OH, April 22-25, 1985, Proceedings . Columbus, OH, Ohio State University, 1985, p. 167-173.

It is pointed out that the first instrument ever used on an aircraft was invented by Wilbur and Orville Wright, and consisted of a piece of string placed in the air stream directly in front of the pilot. Gradually, it was realized that a pilot's equilibrium does not depend on the semicircular canals of the inner ear and the muscular sense, but on the visual sense. This development led to the invention of the 'Vertigo Stopper Box' by Ocker, and to the publication of the book 'Blind Flight in Theory and Practice', coauthored by Ocker and Crane in 1932. Another advance due to Crane was the first instrument simulator with ratio guidance features for instrument flight training applications. In tests conducted in 1930, it was found that Crane's flight integrator made it possible to eliminate vertigo, while the first blind landing was performed by Doolittle in 1929. Attention is also given to the evolution of the USAF Instrument Flight Center, and the possible advantages of the Crane Flitegage. G.R.

A86-30549
HELICOPTER MAINTENANCE IN THE REAL WORLD
G. R. VANSLYKE (Okanagan Helicopters, Ltd., Richmond, Canada) Vertiflite (ISSN 0042-4455), vol. 32, Mar.-Apr. 1986, p. 24-28.

The need to minimize helicopter operating and maintenance costs and improve reliability and durability is examined. It is estimated that large current generation helicopters cost $1,000/flying hour; the largest cost is engine repair followed by accessory repair. The improvements required in field maintenance, repair shop maintenance, and helicopter and engine design and developments are described. The use of in-house repair services and overhaul capabilities has reduced maintenance costs. The elimination of helicopter design problems such as vibrations, corrosion, water leaking, and the removal of finite-lifted components, by the manufacturer is studied. I.F.

A86-31038
WHAT TECHNOLOGIES AWAIT THE FUTURE AIRLINER?
P. CONDOM and M. LAMBERT Interavia (ISSN 0020-5168), vol. 41, Feb. 1986, p. 145-149.

The present assessment of technology readiness in the fields of airliner aerodynamics, structures, avionics, control systems, and propulsion, attempts to forecast the likely character of the next generation in commercial aircraft design. Although both political and commercial pressures exist for renewed efforts toward a second-generation SST, current technology development efforts are centered on continued refinement of laminar aerodynamics, propfan and unducted fan propulsion, thermoplastic matrix composites and aluminum-lithium alloys for structures and digital avionics and control. Attention is given to the boundary layer wing-skin suction flow laminarization technique and the competition between engine manufacturer's innovative propfan technologies. O.C.

A86-31330#
X-AIRCRAFT FOR WORLD LEADERSHIP IN AERONAUTICS
R. S. COOPER Aerospace America (ISSN 0740-722X), vol. 24, Feb. 1986, p. 26-28.

Continuing vigorous and sufficiently funded aeronautical research involving experimental aircraft is a necessity if the U.S. is to retain world leadership in aerospace defense and industrial technologies. The most recent program, the X-29, illustrates the process of demonstrating a proof of concept as a key effort in introducing new ideas into operational aircraft. The alternative to flight testing experimental demonstrator aircraft can be several years of studies in wind tunnels and in computer time, substantially increasing program costs and usually producing only an incremental increase in performance instead of an integer multiplicative advance. The next likely demonstrator program will be the DARPA-NASA X-wing circulation control (CC) rotor aircraft. CC experiments will examine techniques for generating lift, providing distributed propulsion and controlling drag, concepts which may eventually be applied in long-endurance high altitude atmospheric aircraft that may replace geosynchronous satellites. A subsequent program to develop a hydrogen-fueled aerospaceplane powered by a supersonic-combustion ramjet propulsion system may encounter funding obstacles when the time comes to construct a demonstrator experimental aircraft near the end of the 1980s. M.S.K.

A86-31340#
HOW SWEDEN DECIDED TO BUILD THE GRIPEN
S.-O. HOEKBORG (Forsvaret Materielverk, Stockholm, Sweden) Aerospace America (ISSN 0740-722X), vol. 24, March 1986, p. 48-50.

The Swedish aerospace defense industry was initiated in the 1940s after foreign manufacturers failed to make deliveries. The series of aircraft that followed included the J-29 Flying Barrel, first operational in 1951, followed by the 32-Lansen, the J-35 Draken (early delta-wing configuration), and the 37 Viggen. Budgetary constraints starting in the 1970s increased the need for a multirole fighter such as the F-16. When the Swedish government began considering foreign fighters such as the F-16 and Mirage 2000, a consortium of Swedish aerospace firms was formed, which developed a proposal for the JAS-39 Gripen. The design was accepted by the Swedish government as the Swedish multirole fighter into the 21st century. It is noted that the prospects of keeping the aerospace employment levels high in Sweden was an influential factor in the decision. M.S.K.

A86-31848
EXPERT SYSTEMS IN THE FIGHTER OF THE 1990S
R. M. YANNONE (General Electric Co., Aerospace Electronic Systems Dept., Utica, NY) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 1, Feb. 1986, p. 12-16.

The development of a multibeam system for the Advanced Tactical Fighter based on mission requirements is examined. The multisensor data fusion and situation assessment expert systems

are described. The fusion sensor operates over a region of the surveillance volume asynchronously and provides data to maximize target identification and kinematic state vector accuracy. The measurement set level, track file level, and onboard common aperture arrangements for the fusion system are discussed. A block diagram for processing the autonomous sensor track files is provided. The situation assessment control sensor utilizes real-time sensor and historical data to provide display parameters for the pilots, weapon cueing, countermeasure response management, and data collection direction. A table listing the subprocesses of the two expert systems is presented. I.F.

A86-32085#
COMBINED TEST FORCE OPERATIONS AT THE AIR FORCE FLIGHT TEST CENTER
P. D. KENNEDY (USAF, Flight Test Center, Edwards AFB, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 10 p.
(AIAA PAPER 86-9739)

In the interest of time and cost reductions, all major aircraft acquisitions by the U.S. Air Force have since 1972 undergone combined Development Test and Evaluation/Operational Test and Evaluation. The Combined Test Force (CTF) manages the planning and execution of such programs. All support resources are gathered at a single test location, and data are furnished to all participants from a common data base. Attention is presently given to the advantages and disadvantages of the CTF approach; the principal advantages include earlier military participation and total Air Force involvement. O.C.

A86-32086#
PRINCIPAL SITE TESTING CONCEPT WITHIN THE NAVY
J. L. DUNN (U.S. Naval Air Test Center, Patuxent River, MD) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, amd SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 4 p.
(AIAA PAPER 86-9740)

The U.S. Naval Air Test Center began Full Scale Development of the F-18 in 1975 with the goal of eliminating the duplication in facilities, logistics, and test data that previous test programs, involving both Navy and contractor facilities, had generated. The principal site concept employed in the Test Center colocated all test assets, which encompassed developmental aircraft, contractor and Navy test personnel, maintenance personnel, and all unique test equipment. Success with the F-18 led to similar programs for the AV 8B and LAMPS MK III aircraft. O.C.

A86-32087#
PRINCIPLES OF FLIGHT TEST
J. R. LARGENT (California, University, Los Angeles) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p.
(AIAA PAPER 86-9742)

This paper discusses a major shortcoming of the conduct of flight test, identifies factors which may aggravate this shortcoming, and proposes a solution. The key to success for this solution is the proper understanding and application of the principles of flight test. Although this paper is based on a lecture given as a part of a continuing education course on Avionics Systems Engineering, the principles described in this paper are generic in nature and are applicable to any system. This paper also describes some methods for applying these principles and identifies some potential pitfalls. Author

A86-32088#
LONG RANGE PLANNING FOR FLIGHT TEST SUPPORT
C. R. HOPPING (USAF, Flight Test Center, Edwards AFB, CA), R. L. COUNTS, and T. A. SCANLAN (BDM Corp., Edwards AFB, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 7 p.
(AIAA PAPER 86-9744)

The U.S. Air Force Flight Test Center has initiated a program for the modernization and improvement of both the Edwards Flight Test Range and the Utah Test and Training Range. Future technical facility requirements have been identified and master planning methods to meet those requirements have been formulated. The goal of these activities is to project requirements, capabilities, funding, procurement actions, and construction programs sufficiently far in advance to ensure adequate support for near future flight test support needs. O.C.

A86-32094#
OPERATIONAL SUITABILITY EVALUATION OF A TACTICAL FIGHTER SYSTEM
A. C. DEMENT and R. D. HARTMAN (USAF, Operational Test and Evaluation Center, Kirtland AFB, NM) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 5 p.
(AIAA PAPER 86-9753)

A tactical fighter is presently evaluated by the U.S. Air Force's Operational Test and Evaluation Center (AFOTEC) methodology. AFOTEC develops a test plan and a separate data management plan to support the suitablility evaluation. After data have been gathered by the AFOTEC test team, a Joint Reliability and Maintainability Evaluation Team categorizes failure data that AFOTEC can employ as a data base for analysis. After the system's current status is assessed, a projection of system maturity is made on the basis of techniques in Military Handbook 189, 'Reliability Growth Management'. Mature reliability projections, maintenance task times, and the planned logistics support structure are inputs to the availability analysis; this uses computer simulations developed or modified in-house. O.C.

A86-32149#
AIAA-86-9827 F-16 RADAR FLIGHT TEST A LESSON IN SOFTWARE DEVELOPMENT
J. KELLEY (USAF, Flight Test Center, Edwards AFB, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 5 p.
(AIAA PAPER 86-9827)

The effects of software development on flight testing of aircraft equipment are investigated. Problems which have evolved in developing software are reviewed. The need for ground testing and two phase flight testing (software and specification compliance) of aircraft components is examined. The relationship between the government and contractors concerning software delivery schedules is discussed. An example decribing the flight testing problems encountered in the software development of the AN/APG-68 Fire Control Radar is provided. I.F.

A86-33226
INTERNATIONAL SYMPOSIUM ON AEROELASTICITY AND STRUCTURAL DYNAMICS, 2ND, RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE, AACHEN, WEST GERMANY, APRIL 1-3, 1985, COLLECTED PAPERS
Symposium organized by DGLR; Supported by BMFT. Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, 713 p. For individual items see A86-33227 to A86-33261, A86-33263 to A86-33291.
(DGLR BERICHT 85-02)

The present conference considers topics in the unsteady aerodynamics and aeroelastic characteristics of aircraft structures, active structural control technologies, structural modeling and optimization methods, structural system identification, and the structural dynamics design verification of space structures. Specific attention is given to the transonic equivalent strip method for aeroelastic applications, transonic unsteady methods for the calculation of flutter airloads, experimental and analytical buffeting investigations of a delta wing, the application of unsteady wing collocation methods to subsonic flow cascades, a static aeroelastic analysis employing aircraft vibration modes, and a general theory for the finite state modeling of aeroelastic systems for active control applications. Also discussed are the use of control law synthesis for gust load alleviation using linear quadratic Gaussian theory, the stiffness control of large space structures, the variation of isotropic behavior in structural optimization, the dynamic analysis

of structures with flexible rotors, modal parameter estimation from driven-base tests, rapid vibration mode analysis of aircraft with external stores, and low frequency design verification of large spacecraft structures. O.C.

A86-33300
INTERNATIONAL HELICOPTER FORUM, 15TH AND INTERNATIONAL AEROSPACE EXHIBITION, HANOVER, WEST GERMANY, MAY 20-27, 1984, REPORTS [INTERNATIONALES HUBSCHRAUBERFORUM, 15TH AND INTERNATIONALE LUFTFAHRT-AUSSTELLUNG, HANOVER, WEST GERMANY, MAY 20-27, 1984, VORTRAEGE]
Bueckeburg, West Germany, Helicopter Center, 1984, 151 p. In German. No individual items are abstracted in this volume.

Various papers on helicopter technology are presented. The topics considered include: military helicopters of the future; Boeing helicopter meeting today's and tomorrow's requirements; new possibilities for fighting helicopters; expanding the applications of military helicopters; and the role of industry in finding military uses for helicopters. Also discussed are: characteristics of the fighting manned helicopters of the future; the new military technologies program at Bell; Project A129, the Army's airborne antitank weapons system; the role of research in future helicopter developments; the influence of new technologies on the design and operation of future helicopter engines; and high technology equipment in aircraft. C.D.

N86-22537# Selenia Industrie Associate S.p.A., Rome (Italy).
RIVISTA TECHNICA SELENIA, VOLUME 9, NUMBER 3, 1985
1985 36 p refs
Avail: NTIS HC A03/MF A01

Electronic and communication automatic test systems are discussed, referring to the Tornado combat aircraft test systems. The subjects include system architecture, the role of advanced computer languages, software quality control, system design analysis and evolution trends.

N86-22538# Selenia Industrie Associate S.p.A., Rome (Italy).
THE MRCA AUTOMATIC TEST SYSTEM
P. CECCHINI *In its* Rivista Technica Selenia, Vol. 9, No. 3, 1985 p 1-6 1985 refs
Avail: NTIS HC A03/MF A01

The automatic test system used to test the Tornado aircraft is described. Each piece of test equipment is dedicated to a single technological class, defined on the basis of the frequency range at which it operates, from low frequency to microwave. Avionics is conceived as a set of line replacable units tested at self standing test stations including a controller, switching devices, input-output interfaces, and appropriate instrumental configuration (dedicated or common) which carry out the test under the test control program. The interface with the operator is a video display unit. As an example of system performance, the flight computer control time is reduced to one tenth of the normal time required.
Author (ESA)

N86-22539# Selenia Industrie Associate S.p.A., Rome (Italy). Aircraft Support Equipment Group.
COMPLEX SYSTEMS INTEGRATED LOGISTIC SUPPORT: AUTOMATIC TEST EQUIPMENT (ATE) AND TEST ORIENTED LANGUAGES ROLE
S. DERCOLE *In its* Rivista Technica Selenia, Vol. 9, No. 3, 1985 p 7-11 1985 refs
Avail: NTIS HC A03/MF A01

The choice of language to be used in software design of automatic test equipment is discussed. The Abbreviated Test Language for Avionics Systems (ATLAS) is described and its performances are compared with those of Basic. A very important aspect introduced by ATLAS is that a change of the intrumentation used has no impact on an ATLAS test program. An example of the same program written in ATLAS and in Basic is given. It is also shown that the ATLAS program is considerably shorter.
Author (ESA)

N86-22540# Selenia Industrie Associate S.p.A., Rome (Italy). Aircraft Support Equipment Group.
SELENIA'S CONTRIBUTION TO THE DEVELOPMENT OF SYSTEMS SUPPORT: MICROWAVE AUTOMATIC TEST EQUIPMENT (ATE)
A. TULLI *In its* Rivista Technica Selenia, Vol. 9, No. 3, 1985 p 12-16 1985
Avail: NTIS HC A03/MF A01

The facilities to support onboard radar systems, (active and passive) are described. A fundamental characteristic of the system is that the test simulates the whole of the operational conditions of the equipment itself. The system is implemented by functional elements including the test equipment, hydraulic system, dedicated boards and units, and line replacable unit adapters. The software is divided into base and applications, and is writen in ATLAS language. Author (ESA)

N86-22542# Selenia Industrie Associate S.p.A., Rome (Italy). Aircraft Support Equipment Group.
IMPLICIT ACTIVITIES IN THE POST DEVELOPMENT PHASE
A. TULLI and S. DERCOLE *In its* Rivista Technica Selenia, Vol. 9, No. 3, 1985 p 22-27 1985
Avail: NTIS HC A03/MF A01

Development aspects of automatic test equipment to be supplied to a customer are discussed. A problem arises when a test system evolves after delivery. A study for third level support of automatic test equipment developed for second order level maintenance of the Tornado combat aircraft is included. Configuration control in three distinct intervention areas (documentation, hardware, and control) is also discussed.
Author (ESA)

N86-22543# Selenia Industrie Associate S.p.A., Rome (Italy). Aircraft Support Equipment Group.
LINES OF EVOLUTION
A. TULLI *In its* Rivista Technica Selenia, Vol. 9, No. 3, 1985 p 28-31 1985
Avail: NTIS HC A03/MF A01

Advice on electronic test equipment choice criteria is given. The configuration and modularity of hardware and software are examined. Global life cycle cost is negotiable against efficiency parameters at an early stage of system design. Author (ESA)

N86-22545# Joint Publications Research Service, Arlington, Va.
SCIENTISTS ON AIRCRAFT DEVELOPMENT TRENDS
M. GOLUBEVA and V. ZASIMOV *In its* USSR Report: Transportation (JPRS-UTR-86-001) p 1-5 24 Jan. 1986 Transl. into ENGLISH from Grazhdanskaya Aviatsiya (Moscow, USSR), no. 9, Sep. 1985 p 22-23
Avail: NTIS HC A04

Fuel consumption and the production of aircrafts and aviation fuels is discussed. Problems in producing synthetic fuels from shale oil, bituminous coal, and hydrogen are outlined. Fuel conservation which should be configurated in aircraft design, materials, and construction is discussed. Polymer composites for use in aircraft construction, such as high modulus fibers of graphite and boron are recommended. It is concluded that the introduction of the new technologies will improve aircraft performance and fuel efficiency. E.A.K.

N86-22775# Joint Publications Research Service, Arlington, Va.
FUZZY INFERENCE SYSTEM TO DIAGNOSE AIRCRAFT HYDRAULIC FAULTS
S. FENG, W. WENG, and L. DONG *In its* China Report: Science and Technology (JPRS-CST-86-010) p 134-141 19 Mar. 1986 refs Transl. into ENGLISH from Shuxue de Shijian yu Renshi (Beijing, China), no. 3, Jul. 1985 p 14-18
Avail: NTIS HC A08/MF A01

Aircraft hydraulic systems, the drive systems which control attitude, extension and retraction of landing gear, and wing flaps, are composed of tens to over a hundred parts. These systems are complex and often give rise to puzzling faults. The application of computers in fault diagnosis can increase precision and speed

so as to conveniently array the prerequisites which create the fault. This is one effective way to improve the quality of aircraft maintenance. The causes of system faults and the appearance of symptoms have a random or Fuzzy nature. In the process of diagnosis the language people use is also largely vague. Based on these statistics combined with fault mechanism analysis, this article takes natural languages and transforms it into machine language and crystallize human experience to simulate a Fuzzy inference system. The characteristic nature of the system is first to select from events a set of symptoms (input) and causes (output) of model fault events and store them in a computer. Then during diagnosis an input works in this system to diagnose the causes (output). B.W.

N86-23552* National Aeronautics and Space Administration, Washington, D.C.
A CUMULATIVE INDEX TO A CONTINUING BIBLIOGRAPHY ON AERONAUTICAL ENGINEERING
1986 521 p
(NASA-SP-7037(196); NAS 1.21:7037(196)) Avail: NTIS HC A22 CSCL 01A

This bibliography is a cumulative index to the abstracts contained in NASA-SP-7037(184) through NASA-SP-7037(195) of Aeronautical Engineering: A Continuing Bibliography. NASA SP-7037 and its supplements have been compiled through the cooperative efforts of the American Institute of Aeronautics and Astronautics (AIAA) and the National Aeronautics and Space Administration (NASA). This cumulative index includes subject, personal author, corporate source, foreign technology, contract, report number, and accession number indexes. Author

N86-23553* National Aeronautics and Space Administration, Washington, D.C.
AERONAUTICAL ENGINEERING (A CONTINUING BIBLIOGRAPHY WITH INDEXES)
Mar. 1986 115 p
(NASA-SP-7037(198); NAS 1.21:7037(198)) Avail: NTIS HC A06 CSCL 01A

This bibliography lists 395 reports, articles, and other documents introduced into the NASA scientific and technical information system in February 1986. Author

N86-23554*# Kentron International, Inc., Hampton, Va.
AN AERODYNAMIC ANALYSIS COMPUTER PROGRAM AND DESIGN NOTES FOR LOW SPEED WING FLAP SYSTEMS Final Report
H. W. CARLSON and K. B. WALKLEY Washington NASA Mar. 1983 75 p refs
(Contract NAS1-16000)
(NASA-CR-3675; NAS 1.26:3675) Avail: NTIS HC A04/MF A01 CSCL 01B

The expanded capabilities for analysis and design of low speed flap systems afforded by recent modifications of an existing computer program is described. The program provides for the simultaneous analysis of up to 25 pairs of leading-edge and trailing-edge flap deflection schedules. Among other new features of the program are a revised attainable thrust estimation method to provide more accurate predictions for low Mach numbers, and a choice of three options for estimation of leading-edge separation vortex flow effects. Comparison of program results with low speed experimental data for an arrow wing supersonic cruise configuration with leading-edge and trailing-edge flaps showed good agreement over most of the range of flap deflections. Other force data comparisons and an independent study of airfoil and wing pressure distributions indicated that wind-tunnel measurements of the aerodynamic performance of twisted and cambered wings and wings with leading-edge flaps can be very sensitive to Reynolds number effects. Author

N86-23555*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SOME LESSONS LEARNED WITH WIND TUNNELS
M. L. SPEARMAN Mar. 1986 40 p refs
(NASA-TM-87710; NAS 1.15:87710) Avail: NTIS HC A03/MF A01 CSCL 01B

A review is presented of some of the lessons learned from wind tunnel tests since World War II. Wind tunnels achieved a very high productivity rate during the war due in part to development testing of numerous military aircraft concepts. Following the war, in addition to development testing, a rapid increase in basic research testing occurred in order to explore areas of interest revealed by the conduct of war and to expand on advanced technology that became available from Germany and Italy. The research test areas discussed are those primarily related to the transition from subsonic flight to supersonic flight. Author

N86-23556# RAND Corp., Santa Monica, Calif.
DEPOT MAINTENANCE OF AVIATION COMPONENTS: CONTRACTOR VERSUS ORGANIC REPAIR
L. B. EMBRY, N. Y. MOORE, J. CAVE, and F. LABRUNE Mar. 1985 116 p
(Contract N00014-83-C-0100)
(AD-A162071; RAND/N-2225-NAVY) Avail: NTIS HC A06/MF A01 CSCL 01C

Aviation and engine component repair requirements make up over half of the projected wartime depot-level maintenance workload. Organic (service-owned) ability to support this workload is particularly limited; at present, nearly half of the Navy's depot-level component repair is performed in contractor or other service facilities. Before major investments are made in the facilities and equipment needed to accomplish these repairs, it will be necessary to determine the appropriate mix of organic and contractor repair sources. This note addresses the economic and operational implications of alternative source-of-repair decisions. Based on analyses of the distribution of projected wartime demands, technical data limitations, the structure of the repair industry, the operational payoff of facilities characterized by broad scope of repair, and airline industry practices, it postulates a strategy for providing depot-level component support that can be used to specify the appropriate source of repair at different points in the weapon system and subsystem life cycle. GRA

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A86-30213#
RECOMBINATION OF VORTEX FILAMENTS AND ITS ROLE IN AERODYNAMIC NOISE
R. TAKAKI (Tokyo University of Agriculture and Technology, Fuchu, Japan) and A. K. M. F. HUSSAIN (Houston, University, TX) IN: Symposium on Turbulent Shear Flows, 5th, Ithaca, NY, August 7-9, 1985, Proceedings . University Park, PA, Pennsylvania State University, 1985, p. 3.19-3.25. refs
(Contract NSF MEA-81-11676; NSF INT-84-14714)

The recombination of two vortex filaments in a viscous incompressible fluid is analyzed by the use of the vorticity equation. The analysis is confined to a local flow field where the recombination process occurs, and is based on several assumptions, such as conservation of the fluid impulse, spatial symmetry of the flow field, etc. The flow field is expanded as polynomials of coordinates, and variations of their coefficients are obtained by the use of the vorticity equation. It is proved that the process is completed within a short time of 0(sigma-squared/Gamma), and that the viscous effect is essential; sigma and Gamma are the size and the circulation of the filaments,

respectively. The result is applied to predict the far-field noise of a circular jet by assuming that the main noise source is the recombination process in deformed vortex rings in the jet near field. The predicted noise intensity shows the U to the 8th dependence and has an additional new factor (d/sigma) to the 6th; U is the jet velocity and d is the average spacing between vortex rings. The predicted intensity distribution is directional even without the effect of source convection. Author

A86-30734#
A METHOD FOR COMPUTER AIDED DESIGN OF TRANSONIC TURBINE CASCADE
Y. AHAO, T. ZHAN, H. XIAO, J. ZHENG, and Z. WU (Nanhua Power Plant Reseach Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 6, Oct. 1985, p. 449-454. In Chinese, with abstract in English.

A computer-aided design method for transonic turbine aerofoil shaping and thermodynamic analysis is presented. The method adopts the technique of 'Computational Geometry' developed for blade space shaping. An improved Streamline Curvature method for cascade analysis, called CASC, is applied to blade-to-blade stream surface analysis. Its advantage over the conventional streamline curvature method lies in using oblique computational stations. On the basis of choosing the throat as a basic computational station, all oblique computational stations are generated from input data by circular spline fitting and interpolating. A high-loaded turbine cascade with anti-convex suction surface near the trailing edge has been designed with success by this method. Its appreciable supersonic performance is proven in wind tunnel tests. This method is a core module of a 'Turbine Blade Computer Aided Design System' (GTCAD). Author

A86-31013#
EFFECTS OF INTENSE RAINFALL ON THE AERODYNAMICS OF AN AIRFOIL PROFILE [EFECTOS DE LA LLUVIA INTENSA SOBRE LA AERODINAMICA DE UN PERFIL]
A. FEO PALACIOS (Instituto Nacional de Tecnica Aeroespacial, Madrid, Spain) IAA/Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), Jan. 1986, p. 35-41. In Spanish. refs

Recent studies have indicated that the effects of intense rainfall on aircraft lift can catastrophically degrade flight capabilities in the presence of other adverse atmospheric conditions. Attention is presently given, first, to several illustrative case histories, and then to a physical description of the characteristics of intense rainfall. Quantitative rainfall effects on NACA and Wortman airfoil profiles obtained by previous studies are noted. O.C.

A86-31020#
A CORRECTION OF THE ANGLE OF INCIDENCE FOR A TWO-DIMENSIONAL WING MODEL IN THE CLOSED TEST SECTION
K. ABE Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 383, 1985, p. 689-696. In Japanese, with abstract in English. refs

In low-speed wind tunnel testing for a two-dimensional wing model, a correction to the angle of incidence is considered due to the nonuniform spanwise distribution of lift. This phenomenon is concerned with the change of the effective angle of incidence, which results from the interference between the wing tip and tunnel wall perpendicular to the wing span. Since the change of the effective angle of incidence is connected with the induced drag according to the lifting-line wing theory, the change of the effective angle of incidence may be estimated if the induced drag could be determined by experiment. In this study, the induced drag is obtained by the difference between the total drag measured by the wind tunnel balance and the profile drag determined by the wake measurements. The result with this correction to the angle of incidence is in good agreement with reliable experimental data. Author

A86-31021#
IMPROVED NUMERICAL METHOD FOR LIFTING AIRFOILS WITH OSCILLATING CONTROL SURFACES IN SUBSONIC FLOW
A. ICHIKAWA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 383, 1985, p. 697-703. In Japanese, with abstract in English. refs

A numerical method is presented for the prediction of unsteady loadings on lifting airfoils that are due to oscillations of trailing edge control surfaces in subsonic compressible flow. An asymptotic pressure distribution is used to remove and separately evaluate the singularity in the kinematic downwash distribution. The method gives accurate result, quick convergence and excellent computational efficiency to other current methods. Author

A86-31022#
OUTER SURFACE OF AIRPLANE AND COMPUTATIONAL GRID FOR FLOW ANALYSIS IN PHYSICAL SPACE
M. NAKAMURA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 33, no. 383, 1985, p. 704-709. In Japanese, with abstract in English.

For the purpose of numerical analysis of three-dimensional compressible steady flow around an airplane, it is necessary to find quantitatively local positions of an outer surface of the airplane and local directions of the surface in a rectangular computational grid system in physical space. The outer surface of the airplane is made up of many elements of small triangular planes. The local positions of the outer surface in the grid system are determined by local interactions of axes of the grid with these triangular planes. Directions of the triangular planes are substituted for the local directions of the outer surfaces. Using these results, views of the outer surface of airplane are drawn in sheets of paper. Author

A86-31132
ON THE EXACT SOLUTION OF THE LINEARIZED LIFTING-SURFACE PROBLEM OF AN ELLIPTIC WING
A. HAUPTMAN and T. MILOH (Tel Aviv University, Israel) Quarterly Journal of Mechanics and Applied Mathematics (ISSN 0033-5614), vol. 39, Feb. 1986, p. 41-66. refs

An analytic solution is presented for the lifting-surface problem of a thin circular or elliptic wing in steady incompressible potential flow. The analysis is based on expansion of the acceleration potential in an infinite series of ellipsoidal harmonics. Unlike previous analyses, which involve inversion of infinite sets of linear equations or the numerical solution of integral equations, the present method leads to rather simple explicit expressions for the lift and moment coefficients in terms of the aspect ratio. These expressions are valid in the whole range of aspect ratios from the two-dimensional airfoil through the circular wing to the slender wing. Author

A86-32154#
UNSTEADY STALL MODELLING IN THREE-DIMENSIONAL FLOW
C. COSTES, J. J. COSTES, and D. PETOT (ONERA, Chatillon-sous-Bagneux, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 4, 1985, p. 59-61. refs

A two-dimensional model that determines aerodynamic forces using nonlinear coupled differential equations is presented. The model expresses nonlinear and three-dimensional effects. The application of the model to the evaluation of unsteady aerodynamic forces on a straight rectangular wing model is described; data for large-amplitude oscillations at zero sweep are obtained. Experimental and theoretical data are compared and good correlation is observed. I.F.

A86-32324#
AIRCRAFT AND ROCKETS: DESIGN CONCEPTS [AVIOANE SI RACHETE: CONCEPTE DE PROIECTARE]
M. M. NIA, F. V. MORARU, and R. N. PATRAULEA Bucharest, Editura Militara. 1985, 303 p. In Romanian. refs

After a brief historical review of the Romanian aviation, the book details design concepts and principles of aircraft and rocket construction and aerodynamics. Topics discusssed include wing geometry and profiles (NACA, ONERA, Tsagi, RAF), aileron and flap theory, and fuselage construction; also discussed are aerodynamics of the tail ensemble and lift and drag problems. Rocket subjects include supersonic flight regimes, ballistic laws and trajectory and reentry theories. Angle-of-attack and angle-of-incidence computations are presented, together with theories and problems of the propeller and jet propulsion systems. The book is recommended for academic as well as military circles. N.D.

A86-32739
FLOW STRUCTURE AT THE WINDWARD SIDE OF CONICAL WINGS WITH AN ATTACHED SHOCK WAVE AT THE LEADING EDGE [O STRUKTURE TECHENIIA OKOLO NAVETRENNOI STORONY V-OBRAZNYKH KRYL'EV S PRISOEDINENNOI UDARNOI VOLNOI NA PEREDNIKH KROMKAKH]
M. A. ZUBIN and N. A. OSTAPENKO Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Jan.-Feb. 1986, p. 122-131. In Russian. refs

Results of numerical calculations of symmetric supersonic flow of a gas past the windward side of conical wings with a dihedral angle of 40 deg and apex angles of 30, 45, and 90 deg are presented for Mach 3. The fact that one or two Ferri points may move up from the corner point of the wing profile is discovered and explained. It is shown that conical flow past wings of finite length may discontinue at regimes corresponding to angles of attack at which the Ferri point moves up. V.L.

A86-32777#
EXPERIMENTAL ANALYSIS OF A PITOT-TYPE AIR INTAKE
D. WELTE (Dornier GmbH, Friedrichshafen, West Germany) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 266-274. Research supported by the Bundesministerium der Verteidigung. Previously cited in issue 20, p. 2845, Accession no. A84-41350.

A86-32779#
SOLUTION OF THE UNSTEADY EULER EQUATIONS FOR FIXED AND ROTOR WING CONFIGURATIONS
N. L. SANKAR, B. E. WAKE, and S. G. LEKOUDIS (Georgia Institute of Technology, Atlanta) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 283-289. Army-supported research. Previously cited in issue 07, p. 838, Accession no. A85-19531. refs

A86-32780*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
UNSTEADY TRANSONIC FLOW CALCULATIONS FOR TWO-DIMENSIONAL CANARD-WING CONFIGURATIONS
J. T. BATINA (NASA, Langley Research Center, Hampton, VA) (Structures, Structural Dynamics, and Materials Conference, 26th, Orlando, FL, April 15-17, 1985, Technical Papers. Part 2, p. 1-9) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 290-298. Previously cited in issue 13, p. 1845, Accession no. A85-30320. refs

A86-32781#
COMPUTATION OF PROP-FAN ENGINE INSTALLATION AERODYNAMICS
C. W. BOPPE and B. S. ROSEN (Grumman Aerospace Corp., Bethpage, NY) (International Council of the Aeronautical Sciences, Congress, 14th, Toulouse, France, September 9-14, 1984, Proceedings. Volume 1, p. 580-590) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 299-305. Previously cited in issue 22, p. 3172, Accession no. A84-44994. refs

A86-32782*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AERODYNAMIC PARAMETERS ESTIMATED FROM FLIGHT AND WIND TUNNEL DATA
V. KLEIN (NASA, Langley Research Center; Joint Institute for Advancement of Flight Sciences, Hampton, VA) and J. G. BATTERSON (NASA, Langley Research Center, Hampton, VA) (International Council of the Aeronautical Sciences, Congress, 14th, Toulouse, France, September 9-14, 1984, Proceedings. Volume 2, p. 1038-1046) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 306-312. Previously cited in issue 22, p. 3197, Accession no. A84-45042. refs

A86-32784#
INVESTIGATION OF VORTEX PATTERNS ON SLENDER BODIES AT HIGH ANGLES OF ATTACK
G. WU, T. WANG, and S. TIAN (Nanjing Aeronautical Institute, People's Republic of China) (International Council of the Aeronautical Sciences, Congress, 14th, Toulouse, France, September 9-14, 1984, Proceedings. Volume 2, p. 763-771) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 321-325. Previously cited in issue 22, p. 3173, Accession no. A84-45012. refs

A86-32785#
OPTIMUM SUPERSONIC WINGS WITH SUBSONIC LEADING EDGES
H. J. BOS (Delft, Technische Hogeschool, Netherlands) (International Council of the Aeronautical Sciences, Congress, 14th, Toulouse, France, September 9-14, 1984, Proceedings. Volume 2, p. 1256-1262) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 326-332. Previously cited in issue 22, p. 3175, Accession no. A84-45069. refs

A86-32789#
EXPERIMENTAL AND THEORETICAL STUDY OF WINGS WITH BLUNT TRAILING EDGES
V. RAMJEE, E. G. TULAPURKARA, and V. BALABASKARAN (Indian Institute of Technology, Madras, India) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 349-352. refs

The effects of blunt trailing edges on the performance of an aircraft are experimentally and theoretically evaluated. A teak wood model with sharp trailing-edged wings and a chord of 0.2 m, and four models with blunt trailing edges and chords of 0.19, 0.18, 0.17, and 0.16 m are tested at the speed of 32 m/s. The lift coefficient, wing drag, slope of the lift curve, and aerodynamic efficiency are examined. The data reveal that for a slightly blunt trailing edge there is no significant affect on aerodynamic characteristics; however, when the bluntness increased the slope of the lift curve, the maximum lift coefficient, and drag coefficient increase and the aerodynamic efficiency decreases. The simplified Martensen surface vorticity technique of Lewis (1980) is used to calculate potential flow past airfoils with blunt trailing edges. It is observed that the slope of the lift curve increases from 0.1195 to 0.138 when the cutoff is increased from 0-50 percent of the chord. I.F.

A86-32959#
AERODYNAMIC CHARACTERISTICS OF A FLEXIBLE MEMBRANE WING
S. GREENHALGH (U.S. Navy, Naval Air Development Center, Warminster, PA) and H. C. CURTISS, JR. (Princeton University, NJ) AIAA Journal (ISSN 0001-1452), vol. 24, April 1986, p. 545-551. refs
(AIAA PAPER 84-2168)

The results of experimental studies of the aerodynamic characteristics of single-surface membrane wings constructed of inextensible flexible material are described and compared with theory. The experiments included measurement of the lift and drag characteristics of semispan wing models of three different planforms (triangular, parabolic, and elliptical). The wing surfaces were constructed of 2- and 4-mil stainless steel shim stock attached to a streamline leading-edge spar. This very thin metal membrane

is flexible and adjusts its shape in response to the airflow over the wing surface. The experimental apparatus permitted variation of the camber and twist distribution of the wing. A unique method of describing the geometry of the wing is presented and used to correlate the experimental results and to compare experiment with theory. The experimental results agree well with lifting line theory below stall using the method presented for determining the geometric shape of the wing. The wing with the parabolic planform exhibited the best aerodynamic characteristics compared to the triangular and elliptical planforms. The maximum lift coefficients and lift-to-drag ratios measured are comparable to conventional rigid wings. Various dynamic phenomena encountered during the experiments are described. Author

A86-32960*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EULER AND NAVIER-STOKES SOLUTIONS FOR FLOW OVER A CONICAL DELTA WING
R. W. NEWSOME (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 24, April 1986, p. 552-561. Previously cited in issue 07, p. 837, Accession no. A85-19526. refs

A86-32966#
COMPARATIVE STUDY BETWEEN TWO NAVIER-STOKES ALGORITHMS FOR TRANSONIC AIRFOILS
M. R. VISBAL and J. S. SHANG (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA Journal (ISSN 0001-1452), vol. 24, April 1986, p. 599-606. Previously cited in issue 07, p. 847, Accession no. A85-19777. refs

A86-32978#
DYNAMIC STALL INCEPTION CORRELATION FOR AIRFOILS UNDERGOING CONSTANT PITCH RATE MOTIONS
J. H. STRICKLAND and G. M. GRAHAM (Texas Tech University, Lubbock) AIAA Journal (ISSN 0001-1452), vol. 24, April 1986, p. 678-680. Research supported by the Sandia National Laboratories. refs
(Contract F49620-82-C-0035)

Most of the experimental data obtained to date for unsteady separated flow over airfoils undergoing constant pitch rate motions have been obtained from oscillating airfoils undergoing relatively small sinusoidal pitch oscillations about a relatively low mean angle of attack. Attention is presently given to two tank flow visualizations in which a NACA 0015 airfoil was mounted on a carriage that imparted translational motion as well as constant rates of pitching about the quarter-chord. Hydrogen bubbles provided the flow visualizations, which appeared to be two-dimensional in character. Separation was noted to usually occur at the leading edge, at angles-of-attack that may greatly exceed the static stall angle. O.C.

A86-32979#
SIMULATION OF INVISCID VORTEX-STRETCHED TURBULENT SHEAR-LAYER FLOW
A. RIZZI (Flygtekniska Forsoksanstalten, Bromma, Sweden) and C. J. PURCELL (ETA Systems, Inc., St. Paul, MN) AIAA Journal (ISSN 0001-1452), vol. 24, April 1986, p. 680-682.

Computational simulations are conducted for a vortex flowfield that develops when a delta wing meets an oncoming stream of air at a high angle-of-attack. If the Reynolds number of the flow is of the order of 10 million or larger, the shear stresses and dissipation terms take effect only in very thin layers of the flow on the surface of the wing and across the shear layers that separate from the leading and training edges. Attention is given to the dynamics and the stability of these free shear layers by means of numerical simulations that solve Euler equations with an artificial viscosity model. The flow is inviscid except across thin discontinuities like shock waves and vortex sheets. O.C.

A86-32987*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
MACH REFLECTION AND AERODYNAMIC CHOKING IN TWO-DIMENSIONAL DUCTED FLOW
A. KUMAR (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 24, April 1986, p. 695-697.

Flow through a two-dimensional duct with supersonic inflow is numerically investigated, from the viewpoint of the formation of Mach reflection, aerodynamic choking, and the possibility of constructing a curve similar to that for the quasi-one-dimensional flow in a converging-diverging duct. Such a curve can be used to determine whether a duct with a certain area ratio will or will not choke for a given inflow Mach number. Plots of pressure and mass flux contours are obtained for a given duct configuration. It is found that the two-dimensional flow always chokes at a higher Mach number than the corresponding quasi-one-dimensional flow for a given throat/inlet flow area ratio. O.C.

A86-32989#
AIRFOIL DESIGN AT SONIC VELOCITY
B. LING (Nanchang Aircraft Co., People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 4, March 1986, p. 1-10. In Chinese, with abstract in English. refs

A numerical finite difference method for calculating a hodograph solution at free-stream Mach number 1 is described. The exact hodograph formulation is used in the calculation. Because of the singularity of the far field boundary condition in the physical plane, which is mapped to a singular point on the hodograph plane, the approximate analytical solution of the Tricomi equation is employed. The boundary curves of five examples for the numerical calculations in the hodograph plane are described by the spline method. A family of airfoil shapes and their pressure distribution, drag, lift, and moment about the leading edge are presented. These sonic airfoil designs may be useful for assessing the near sonic aircraft performance. Author

A86-32990#
THE PASSIVE CONTROL OF THE SHOCK WAVES ON TRANSONIC AIRFOILS
G. SAVU (Aviation Institute, Bucharest, Rumania) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 4, March 1986, p. 11-18. refs

A method for the attenuation of shock waves on airfoils in supercritical flow is presented. By numerically solving the inviscid, small disturbance equation in steady transonic regime, with boundary conditions on solid or porous airfoils, the corresponding pressure distribution is obtained. Comparing the pressure distribution in both cases, one may observe that for the porous airfoils a gradually recompression towards the trailing edge is occuring, without strong shock waves, in a quite large Mach number domain, in opposition to the known fact that supercritical airfoil optimization is valid only in a very close vicinity of the design Mach number and incidence. For a given Mach number and incidence, the calculated pressure distribution on the airfoil having porous regions, is used to generate the contour of an equivalent solid airfoil whose shape resembles that of an supercritical airfoil. Author

A86-32994#
AN IMPROVEMENT TO THE NUMERICAL METHOD FOR CALCULATIONS OF AIRCRAFT CONFIGURATION LONGITUDINAL AERODYNAMIC CHARACTERISTICS
Z. JIANG (China Aerodynamic Research and Development Center, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 4, March 1986, p. 56-64. In Chinese, with abstract in English. refs

Based on the subsonic and supersonic potential theory, an improved numerical method is developed for the calculation of the surface pressure distribution on an aircraft and then the force and moment by integrating the pressure distributions, using surface distribution finite element solutions. With concepts of joint flow field and the effective section thrust and strip turbulent boundary layer theory, an improved drag calculation can be obtained. A

computer program has been developed. Several examples of calculated aerodynamic characteristics are presented, and good agreement between calculation results and experimental data can be achieved. Author

A86-33227* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
CALCULATION OF TRANSONIC STEADY AND OSCILLATORY PRESSURES ON A LOW ASPECT RATIO MODEL AND COMPARISON WITH EXPERIMENT
R. M. BENNETT, E. C. WYNNE (NASA, Langley Research Center, Hampton, VA), and D. G. MABEY (Royal Aircraft Establishment, Dynamics Laboratory, Bedford, England) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 1-16. Previously announced in STAR as N85-32092. refs

Pressure data measured by the British Royal Aircraft Establishment for the AGARD SMP tailplane are compared with results calculated using the transonic small perturbation code XTRAN3S. A brief description of the analysis is given and a recently developed finite difference grid is described. Results are presented for five steady and nine harmonically oscillating cases near zero angle of attack and for a range of subsonic and transonic Mach numbers. Author

A86-33228
TRANSONIC EQUIVALENT STRIP METHOD FOR AEROELASTIC APPLICATIONS
D. D. LIU, Y. F. KAO (Arizona State University, Tempe), and K. Y. FUNG (Arizona, University, Tucson) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 17-32. Navy-supported research. refs

As an engineering tool for aeroelastic applications, the present Transonic Equivalent Strip (TES) method has established an efficient and cost-effective procedure for unsteady flow computations of arbitrary wing planforms including control surfaces. According to the nature of three-dimensional unsteady transonic flow, a method based on the TES model is developed which consists of two consecutive correction steps to a given unsteady two-dimensional code. The latter could be a time-linearized transonic code or a nonlinear one such as LTRAN2 code. First, the mean-flow correction step which involves an equivalent airfoil design procedure; second, the spanwise phase correction step which accounts for the effects of acoustic wave propagation in three dimensions. Computed results using the TES method are compared with those obtained by the current methods such as various versions of XTRAN3 code, Isogai's full potential code and measured data provided by NLR and by RAE. Computed cases include the Northrop F-5 wing in pitching oscillation, the AGARD standard RAE wing with an oscillating flap and the LANN wing in pitching oscillation. Assessments of the present approach and other existing methods will be given. Author

A86-33229
CALCULATION OF 3-D UNSTEADY TRANSONIC POTENTIAL FLOWS BY A FIELD PANEL METHOD
R. VOSS (DFVLR, Institut fuer Aeroelastik, Goettingen, West Germany) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 33-46. refs

A calculation method for 3-d transonic flows around oscillating wings is described. It solves the time-linearized unsteady transonic small perturbation equation by an integral equation method with a field panel technique. In a computer code called PTRAN3, the field panel technique is combined with a finite difference method. Accuracy and computer costs of the code are acceptable for routine flutter applications. Results are shown for applications to pitching motions of a rectangular wing and two swept wings (LANN wing and F5 wing) with high and low aspect ratio. Author

A86-33230
APPLICATION OF TRANSONIC UNSTEADY METHODS FOR CALCULATION OF FLUTTER AIRLOADS
H. ZIMMERMANN and S. VOGEL (Messerschmitt-Boelkow-Blohm GmbH, Bremen, West Germany) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 47-61. refs

A supercritical airfoil profile is used as an example of the calculation of steady and unsteady pressure distributions by the application of different unsteady transonic codes; these primarily involve the nonlinear transonic small perturbation (TSP) equation and its time-linearized form, solved by time-marching as well as integral methods. The influence of the coefficient of the nonlinear term, the inclusion of the steady or quasi-steady boundary layer thickness, and the fulfilment of the Rankine-Hugoniot condition on the resulting pressure distribution, are all noted. The inclusion of the boundary layer led to a much larger shift in critical speed for the nonlinear TSP method than for its linearized version. O.C.

A86-33231
EXACT CLOSED-FORM SOLUTIONS FOR NONLINEAR UNSTEADY TRANSONIC AERODYNAMICS
G. A. OYIBO (Fairchild Republic Co., Farmingdale, NY) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 71-79. refs

After establishing the existence of exact, closed form solutions for nonlinear unsteady aerodynamics, the full nonlinear unsteady velocity potential equations for an airfoil are considered and evidence for the ineffectiveness of traditional hodograph methods in solving these equations is presented. A mapping scheme is accordingly used to transform these full nonlinear equations into the hodograph plane; the resulting hodograph equations show that, by prescribing the Jacobian of the transformation ab initio, the exact closed form solutions can be obtained for the nonlinear unsteady aerodynamic characteristics of an airfoil in a potential flow. The shockless transonic results presented show trends that agree with the results of both previous investigators and the available experimental data. O.C.

A86-33232* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
RECENT TRANSONIC UNSTEADY PRESSURE MEASUREMENTS AT THE NASA LANGLEY RESEARCH CENTER CENTER
M. C. SANDFORD, R. H. RICKETTS, and R. W. HESS (NASA, Langley Research Center, Hampton, VA) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 80-98. Previously announced in STAR as N85-23710. refs

Four semispan wing model configurations were studied in the Transonic Dynamics Tunnel (TDT). The first model had a clipped delta planform with a circular arc airfoil, the second model had a high aspect ratio planform with a supercritical airfoil, the third model has a rectangular planform with a supercritical airfoil and the fourth model had a high aspect ratio planform with a supercritical airfoil. To generate unsteady flow, the first and third models were equipped with pitch oscillation mechanisms and the first, second and fourth models were equipped with control surface oscillation mechanisms. The fourth model was similar in planform and airfoil shape to the second model, but it is the only one of the four models that has an elastic wing structure. The unsteady pressure studies of the four models are described and some typical results for each model are presented. Comparison of selected experimental data with analytical results also are included.
Author

A86-33233
STEADY AND UNSTEADY PRESSURE DISTRIBUTIONS ON VARIOUS PROFILES IN SEPARATED SUBSONIC AND TRANSONIC FLOW
H. TRIEBSTEIN (DFVLR, Institut fuer Aeroelastik, Goettingen, West Germany) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 99-119. refs

Steady and unsteady aerodynamic data are obtained for three rectangular wings in two-dimensional flow. Low subsonic speed wind tunnel measurements were made on a wing with oscillating spoiler in pitch about its leading edge, where the airfoil profile was a supercritical MBB-Va2, while the high subsonic and transonic measurements were performed on pitching airfoils about the c/4-axis of both supercritical MBB-A3 and NACA 0012 profiles. The measurements were performed in order to arrive at systematic results with respect to Mach number, reduced frequency, incidence, and oscillation amplitude; these were then to be used in the development and assessment of subsonic and transonic codes. Emphasis is given to the higher harmonic parts of the unsteady pressure in the region of pressure jumps and flow separation. O.C.

A86-33234
AN IMPROVED POTENTIAL GRADIENT METHOD FOR THE CALCULATION OF UNSTEADY AERODYNAMIC PRESSURES ON OSCILLATING WINGS IN SUPERSONIC FLOW
F.-Q. ZHANG and H. FOERSCHING (DFVLR, Aerodynamische Versuchsanstalt, Goettingen, West Germany) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 153-162. refs

A new computation method is presented to calculate unsteady aerodynamic pressure on oscillating wings in supersonic flow. The main feature of this method is the introduction and application of a new integral variable substitution, by which the computer time is reduced considerably together with an improvement of computation accuracy, especially for low supersonic Mach numbers and high reduced frequencies. Comparisons with other methods and experimental results show quits satisfactory agreement. Author

A86-33235
AN EXACT FORMULATION OF THE UNSTEADY AERODYNAMIC THEORY OF LIFTING SURFACES UNDERGOING ARBITRARY SMALL MOTIONS IN A SUPERSONIC FLOW FIELD
L. LIBRESCU (Tel Aviv University, Israel) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 163-168. refs

This paper deals with the development of an exact algorithm allowing determination of the unsteady pressure field on 3D lifting surfaces undergoing arbitrary small motions in a supersonic flow field. The analysis starts with the linearized field equations of isentropic, inviscid compressible aerodynamics. Linearization of the relevant field equations is performed on the basis of the small-disturbance concept. In this framework each flow variable is represented as the superposition of a primary quantity, held to be constant and corresponding to the undisturbed conditions, and of a small-disturbance, stipulated to be an arbitrary time-dependent quantity. Author

A86-33236
APPLICATION OF UNSTEADY WING COLLOCATION METHODS TO CASCADES IN SUBSONIC FLOW
A. KLOSE and B. LASCHKA (Braunschweig, Technische Universitaet, Brunswick, West Germany) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 180-186. refs

The acceleration potential has been used to reformulate the integral equation relating pressure and downwash on the blades of cascades. In the present investigation harmonically oscillating blades in subsonic flow have been considered. A collocation method as used in lifting surface theories for single airfoils has been adapted to solve the cascade equation. Pressure distribution and airforces have been calculated for several values of stagger, reduced frequency, space-to-chord ratio, Mach number, and inter-blade phase angle. The results have been compared to those published in other reports and, in some cases, significant differences have been discovered. Author

A86-33238* California Univ., Los Angeles.
A NEW LOOK AT ARBITRARY MOTION UNSTEADY AERODYNAMICS AND ITS APPLICATION TO ROTARY-WING AEROELASTICITY
P. P. FRIEDMANN (California, University, Los Angeles) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 194-210. refs
(Contract NAG2-209)

This paper presents in a unified manner recent research on arbitrary motion unsteady aerodynamics with an emphasis on applications to a number of rotary wing aeroelastic problems. The term arbitrary motion is used to denote growing or decaying oscillations with a certain frequency. The specific topics treated in this paper are: (1) generalization of Greenberg's theory and its application to hingeless rotor aeroelastic stability; (2) description of a new technique for formulating finite state approximations to unsteady aerodynamic theories, which are suitable for both fixed-wing and rotary-wing applications, and its application to generalize Loewy's theory; (3) comparison of fixed wing and rotary-wing indicial response functions; (4) influence of a arbitrary motion aerodynamics, as represented by dynamic inflow on a helicopter in ground resonance and (5) comparison of dynamic inflow with arbitrary motion unsteady airfoil aerodynamics. From the discussion of these topics a number of useful conclusions on the fundamental nature of arbitrary motion aerodynamics and its role in rotary-wing aeroelasticity are obtained. Author

A86-33240
CALCULATION OF THE LOAD DISTRIBUTION, AERODYNAMIC DERIVATIVES AND DYNAMIC CHARACTERISTICS OF QUASI-STATIC ELASTIC AIRCRAFT
Q. LIU, C. WU, Z. JIAN, and K. WU (Northwestern Polytechnical University, Xian, People's Republic of China) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 219-228. refs

A86-33408
STEADY TRANSONIC FLOW
E. DICK (Gent, Rijksuniversiteit, Ghent, Belgium) IN: Encyclopedia of fluid mechanics. Volume 1 . Houston, TX, Gulf Publishing Co., 1986, p. 510-532. refs

Steady flows in which some regions of the flow field are subsonic and other regions are supersonic are studied. Basic equations for the steady adiabatic flow of an inviscid fluid are derived, and some one-dimensional examples are treated. It is shown that a stationary compression shock can exist in a steady flow, and the relations between flow properties on both sides of the shock wave are analyzed. The flow in a convergent-divergent duct with a slowly

varying S-section, such that the flow can be considered to be uniform in each section, is considered. Two-dimensional transonic flow is considered, including its general appearance, the effect of viscosity, transonic flow past an airfoil, transonic flow in cascades, and transonic shockless flow. The mathematical character of the Euler equations is analyzed, and the potential flow simplification is described. C.D.

A86-33409
NUMERICAL MODELING OF TRANSONIC FLOWS OVER AIRFOILS AND CASCADES
X.-H. ZHOU, S.-L. LIU, and F.-D. FAN (Northwestern Polytechnical University, Xian, People's Republic of China) IN: Encyclopedia of fluid mechanics. Volume 1 . Houston, TX, Gulf Publishing Co., 1986, p. 533-559. refs

Numerical modeling of inviscid transonic flows around airfoils and in cascades is considered. The basic governing equations, computational mesh, discretization techniques for governing equations, boundary conditions, artificial dissipation, and methods of accelerating convergence are discussed. A time-dependent method for solving the Euler equations is stressed, discussing cascade flow computations in some detail. Some numerical results are presented to illustrate the accuracy and limitations of the numerical modeling. C.D.

A86-33480
AERODYNAMICS AND MOLECULAR GAS DYNAMICS [AERODINAMIKA I MOLEKULIARNAIA GAZOVAIA DINAMIKA]
V. V. STRUMINSKII Moscow, Izdatel'stvo Nauka, 1985, 240 p. In Russian. refs

A series of fundamental problems of practical interest in aerodynamics and molecular gasdynamics are treated using methods of the boundary layer theory and the kinetic theory of gases. Problems examined include the proof of the existence of the slip effect on rectangular wings of infinite aspect ratio and the conditions under which this effect is observed for wings with various degrees of sweep; the effect of acceleration on the structure of a boundary layer, its separation, and drag at low velocities; and the development of a nonlinear stability theory for plane laminar flows of a viscous liquid. Other problems discussed include the development of a more general method for solving Boltzmann equations and the development of a new nonequilibrium kinetic theory of gases. V.L.

N86-22546 Virginia Polytechnic Inst. and State Univ., Blacksburg.
ANALYSIS OF DYNAMIC STABILITY DERIVATIVES FOR HIGH ANGLE OF ATTACK AIRCRAFT Ph.D. Thesis
J. S. KO 1985 184 p
Avail: Univ. Microfilms Order No. DA8521331

Modern, high performance aircraft are required to be able to fly and be controlled over a wide variety of flight conditions. In order to predict the aircraft behavior and control requirements over the entire flight regime it is necessary to have a proper aerodynamic model. In this research, wind tunnel experiments are performed on an F-5 aircraft model at high angles of attack, with small oscillations about the body oriented roll axis. In addition the free stream environment can be configured in one of three ways: (1) straight uniform flow, (2) curved flow to simulated a horizontal turn, and (3) rolling flow to simulated a roll motion about the relative velocity vector. A description of the wind tunnel velocity and the recently developed roll oscillatory rig is given. In addition new linearized equations of motion are developed for describing the small roll oscillation in the non-uniform flow environment. These equations are used to reduce the data obtained in the wind tunnel experiments in order to obtain the usual combined rotary and unsteady aerodynamic stability derivatives as well as new combinations of pure rotary derivatives obtainable only with the non-uniform flow conditions. Dissert. Abstr.

N86-22548 California Univ., Los Angeles.
UNSTEADY AERODYNAMICS IN TIME AND FREQUENCY DOMAINS FOR FINITE-TIME ARBITRARY MOTION OF HELICOPTER ROTOR BLADES IN HOVER AND FORWARD FLIGHT Ph.D. Thesis
M. ASGHAR-HESSARI-DINYAVARI 1985 549 p
Avail: Univ. Microfilms Order No. DA8525824

Several incompressible finite-time arbitrary-motion airfoil theories suitable for coupled flag-lag-torsional aeroelastic analysis of helicopter rotors in hover and forward flight are derived. These theories include generalized Greenberg's theory, generalized Loewy's theory, and a staggered cascade theory. The generalized Greenberg's and staggered cascade theories were derived directly in Laplace domain considering the finite length of the wake and using operational methods. The load expressions are presented in the Laplace, frequency, and time domains. Approximate time domain loads for the various generalized theories are obtained by developing finite state models using Pade approximant of the appropriate lift deficiency functions. Three different methods for constructing Pade approximants of the lift deficiency functions were considered and the more flexible one was used. In the second part of this study the influence of finite-state arbitrary-motion time-domain aerodynamics on rotor blade aeroelastic stability was illustrated for hover and forward flight conditions. Dissert. Abstr.

N86-22550*# Boeing Commercial Airplane Co., Seattle, Wash.
FLOW PREDICTION FOR PROPFAN ENGINE INSTALLATION EFFECTS ON TRANSPORT AIRCRAFT AT TRANSONIC SPEEDS Final Report
S. S. SAMANT and N. J. YU Washington NASA Jan. 1986 93 p refs
(Contract NAS1-17250)
(NASA-CR-3954; NAS 1.26:3954) Avail: NTIS HC A05/MF A01 CSCL 01A

An Euler-based method for aerodynamic analysis of turboprop transport aircraft at transonic speeds has been developed. In this method, inviscid Euler equations are solved over surface-fitted grids constructed about aircraft configurations. Propeller effects are simulated by specifying sources of momentum and energy on an actuator disc located in place of the propeller. A stripwise boundary layer procedure is included to account for the viscous effects. A preliminary version of an approach to embed the exhaust plume within the global Euler solution has also been developed for more accurate treatment of the exhaust flow. The resulting system of programs is capable of handling wing-body-nacelle-propeller configurations. The propeller disks may be tractors or pushers and may represent single or counterrotation propellers. Results from analyses of three test cases of interest (a wing alone, a wing-body-nacelle model, and a wing-nacelle-endplate model) are presented. A user's manual for executing the system of computer programs with formats of various input files, sample job decks, and sample input files is provided in appendices. Author

N86-22551# National Aerospace Lab., Tokyo (Japan).
NUMERICAL ANALYSIS OF INVISCID FLOWS ABOUT WING-FUSELAGE COMBINATIONS. PART 1: DEVELOPMENT OF GRID GENERATION CODE YOKUDO-G
T. ISHIGURO, N. KAMIYA, and K. OGUCHI Jul. 1985 61 p refs In JAPANESE:ENGLISH summary
(NAL-TR-864; ISSN-0389-4010) Avail: NTIS HC A04/MF A01

The main purpose of this paper is to numerically analyze inviscid flows about wing-fuselage combinations. In the first series a numerical procedure is presented for grind generation about a wing-fuselage combination by the analytic mapping method. A user's manual for the FORTRAN code of the procedure is also described. Furthermore, many numerical examples are presented in order to show the utility of this code for several wing-fuselage combinations and in order to understand the role of the controllable variables which yield many patterns of mesh distributions. In the next series, numerical analysis of inviscid flows will be carried out under the grids generated by this numerical procedure. Author

N86-22552*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LOW-SPEED WIND-TUNNEL TESTS OF SINGLE- AND COUNTER-ROTATION PROPELLERS
D. M. DUNHAM, G. L. GENTRY, JR., and P. L. COE, JR. Apr. 1986 46 p refs
(NASA-TM-87656; L-16077; NAS 1.15:87656) Avail: NTIS HC A03/MF A01 CSCL 01A

A low-speed (Mach 0 to 0.3) wind-tunnel investigation was conducted to determine the basic performance, force and moment characteristics, and flow-field velocities of single- and counter-rotation propellers. Compared with the eight-blade single-rotation propeller, a four- by four- (4 x 4) blade counter-rotation propeller with the same blade design produced substantially higher thrust coefficients for the same blade angles and advance ratios. The results further indicated that ingestion of the wake from a supporting pylon for a pusher configuration produced no significant change in the propeller thrust performance for either the single- or counter-rotation propellers. A two-component laser velocimeter (LV) system was used to make detailed measurements of the propeller flow fields. Results show increasing slipstream velocities with increasing blade angle and decreasing advance ratio. Flow-field measurements for the counter-rotation propeller show that the rear propeller turned the flow in the opposite direction from the front propeller and, therefore, could eliminate the swirl component of velocity, as would be expected. Author

N86-22553*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECTS OF SOME GEOMETRIC VARIATIONS ON MISSILE AERODYNAMIC CHARACTERISTICS AT SUPERSONIC SPEEDS
M. L. SPEARMAN Feb. 1986 26 p refs Presented at the 24th AIAA Aerospace Sciences Meeting, Reno, Nev., 6-9 Jan. 1986 Previously announced in IAA as A86-19958
(NASA-TM-87683; NAS 1.15:87683) Avail: NTIS HC A03/MF A01 CSCL 01A

A summary of some results from tests of a wing-body general research missile model is presented for a Mach number range up to 4.63. A basic ogive-cylinder body with a length-to-diameter ratio of 10 was used to which was attached a series of wing planforms. The planforms included a family of delta wings and a family of rectangular wings having a constant root chord but varying spans so that wings of constant exposed area could be compared. In addition, a cranked-tip planform was included and a rectangular planform with reduced chord. Some results are presented for wing-body-tail configurations - one utilizing a cranked wing planform and one with wings having a constant root chord and span, but tip chords that were 0, 20, and 40 percent of the root chord. Author

N86-22554*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SUPERSONIC AXIAL-FORCE CHARACTERISTICS OF A RECTANGULAR-BOX CAVITY WITH VARIOUS LENGTH-TO-DEPTH RATIOS IN A FLAT PLATE
A. B. BLAIR, JR. and R. L. STALLINGS, JR. Apr. 1986 21 p refs
(NASA-TM-87659; L-16075; NAS 1.15:87659) Avail: NTIS HC A02/MF A01 CSCL 01A

A wind-tunnel investigation has been conducted at Mach numbers of 1.50, 2.16, and 2.86 to obtain axial-force data on a metric rectangular-box cavity with various length-to-depth ratios. The model was tested at angles of attack from -4 deg to -2 deg. The results are summarized to show variations in cavity axial-force coefficient for deep- and shallow-cavity configurations with detached and attached cavity flow fields, respectively. The results of the investigation indicate that for a wide range of cavity lengths and depths, good correlations of the cavity axial-force coefficients (based on cavity rear-face area) are obtained when these coefficients are plotted as a function of cavity length-to-depth ratio. Abrupt increases in the cavity axial-force coefficients at an angle of attack of 0 deg. reflect the transition from an open (detached) cavity flow field to a closed (attached) cavity flow field. Cavity length-to-depth ratio is the dominant factor affecting the switching of the cavity flow field from one type to the other. The type of cavity flow field (open or closed) is not dependent on the test angles of attack except near the critical value of length-to-depth ratio. Author

N86-22555# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
RANDOM-CHOICE-METHOD SOLUTIONS FOR TWO-DIMENSIONAL PLANAR AND AXISYMMETRIC STEADY SUPERSONIC FLOWS
Z. C. SHI and J. J. GOTTLIEB Jan. 1986 98 p refs
(UTIAS-297; ISSN-0082-5255) Avail: NTIS HC A05/MF A01

A random-choice method (RCM) is developed for obtaining fairly practical and efficient numerical solutions for two-dimensional planar and axisymmetric steady supersonic flows, such as those for sharp-edged planar airfoils, supersonic inlets of aircraft engines, pointed bodies of revolution, supersonic nozzles, and free jets. This method is based on the solution of a Riemann problem, which is the elemental solution of the hyperbolic equations of two-dimensional steady supersonic flows. The Riemann problem consists of two waves separated by a slip stream, and each wave can be either an oblique shock wave or a Prandtly-Meyer expansion wave. Advanced techniques are given for solving the Riemann problem iteratively, handling the boundary conditions along body and free-jet surfaces, and computing only certain parts of flow fields of interest. Many interesting and practical numerical solutions are presented for different types of planar and axisymmetric flows, to demonstrate the applicability, capability, and limitations of the RCM. Numerical results are shown to be in excellent agreement with both known analytical solutions and results from the method of characteristics. Author

N86-22556*# Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
VORTEX BOUNDARY-LAYER INTERACTIONS Semiannual Status Report, 1 Sep. 1985 - 31 Feb. 1986
P. BRADSHAW 1986 14 p
(Contract NAGW-581)
(NASA-CR-176701; NAS 1.26:176701) Avail: NTIS HC A02/MF A01 CSCL 01A

Parametric studies to identify a vortex generator were completed. Data acquisition in the first chosen configuration, in which a longitudinal vortex pair generated by an isolated delta wing starts to merge with a turbulent boundary layer on a flat plate fairly close to the leading edge is nearly completed. Work on a delta-wing/flat-plate combination, consisting of a flow visualization and hot wire measurements taken with a computer controlled traverse gear and data logging system were completed. Data taking and analysis have continued, and sample results for another cross stream plane are presented. Available data include all mean velocity components, second order mean products of turbulent fluctuations, and third order mean products. Implementation of a faster data logging system was accomplished. bg

N86-23559*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STATIC INVESTIGATION OF TWO STOL NOZZLE CONCEPTS WITH PITCH THRUST-VECTORING CAPABILITY
M. L. MASON and J. R. BURLEY, II Apr. 1986 57 p refs
(NASA-TP-2559; L-165052; NAS 1.60:2559) Avail: NTIS HC A04/MF A01 CSCL 01A

A static investigation of the internal performance of two short take-off and landing (STOL) nozzle concepts with pitch thrust-vectoring capability has been conducted. An axisymmetric nozzle concept and a nonaxisymmetric nozzle concept were tested at dry and afterburning power settings. The axisymmetric concept consisted of a circular approach duct with a convergent-divergent nozzle. Pitch thrust vectoring was accomplished by vectoring the approach duct without changing the nozzle geometry. The

nonaxisymmetric concept consisted of a two dimensional convergent-divergent nozzle. Pitch thrust vectoring was implemented by blocking the nozzle exit and deflecting a door in the lower nozzle flap. The test nozzle pressure ratio was varied up to 10.0, depending on model geometry. Results indicate that both pitch vectoring concepts produced resultant pitch vector angles which were nearly equal to the geometric pitch deflection angles. The axisymmetric nozzle concept had only small thrust losses at the largest pitch deflection angle of 70 deg., but the two-dimensional convergent-divergent nozzle concept had large performance losses at both of the two pitch deflection angles tested, 60 deg. and 70 deg. Author

N86-23561*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AERODYNAMIC CHARACTERISTICS OF A SUPERSONIC FIGHTER AIRCRAFT MODEL AT MACH 0.40 TO 2.47
F. J. CAPONE, E. A. BARE, and D. ARBITER (George Washington Univ., Hampton, Va.) Apr. 1986 105 p refs
(NASA-TP-2580; L-16017; NAS 1.60:2580) Avail: NTIS HC A06/MF A01 CSCL 01A

The aerodynamic characteristics of an advanced twin-engine fighter aircraft designed for supersonic cruise have been studied in the Langley 16-Foot Transonic Tunnel and the Lewis 10- by 10-Foot Supersonic Tunnel. The objective of this investigation was to establish an aerodynamic data base for the configuration with flow-through nacelles and representative inlets. The use of a canard for trim and the effects of fairing over the inlets were assessed. Comparisons between experimental and theoretical results were also made. The theoretical results were determined by using a potential vortex lift code for subsonic speeds and a linear aerodynamic code for supersonic speeds. This investigation was conducted at Mach numbers from 0.40 to 2.47, at angles of attack from 0 deg to about 20 deg, and at inlet capture ratios of about 0.5 to 1.4. Author

N86-23562*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECTS OF UPPER-SURFACE NACELLES ON LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF HIGH-WING TRANSPORT CONFIGURATION
L. E. PUTNAM Apr. 1986 70 p refs
(NASA-TP-2579; L-16062; NAS 1.60:2579) Avail: NTIS HC A04/MF A01 CSCL 01A

An investigation has been conducted in the Langley 16-Foot Transonic Tunnel to determine the effects of installing and streamline contouring upper-surface nacelles on the longitudinal aerodynamic characteristics of a high-wing transport configuration. Also investigated were the effects of adding a fairing under the nacelle. The investigation was conducted at free-stream Mach numbers from 0.60 to 0.83 at angles fo attack from -2 deg to 4 deg. Flow-through nacelles were used. Streamline contouring the nacelles substantially reduced the interference drag due to installing the nacelles. Author

N86-23565*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
USER'S GUIDE FOR NASCRIN: A VECTORIZED CODE FOR CALCULATING TWO-DIMENSIONAL SUPERSONIC INTERNAL FLOW FIELDS
A. KUMAR Feb. 1984 70 p
(NASA-TM-85708; L-15678; NAS 1.15:85708) Avail: NTIS HC A04/MF A01 CSCL 01A

A computer program NASCRIN has been developed for analyzing two-dimensional flow fields in high-speed inlets. It solves the two-dimensional Euler or Navier-Stokes equations in conservation form by an explicit, two-step finite-difference method. An explicit-implicit method can also be used at the user's discretion for viscous flow calculations. For turbulent flow, an algebraic, two-layer eddy-viscosity model is used. The code is operational on the CDC CYBER 203 computer system and is highly vectorized to take full advantage of the vector-processing capability of the system. It is highly user oriented and is structured in such a way that for most supersonic flow problems, the user has to make only a few changes. Although the code is primarily written for supersonic internal flow, it can be used with suitable changes in the boundary conditions for a variety of other problems. Author

N86-23566*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
LOCALLY LINEARIZED LONGITUDINAL AND LATERAL-DIRECTIONAL AERODYNAMIC STABILITY AND CONTROL DERIVATIES FOR THE X-29A AIRCRAFT
G. D. BUDD Jan. 1984 480 p
(NASA-TM-84919; H-1203; NAS 1.26:84919) Avail: NTIS HC A21/MF A01 CSCL 01A

The locally linearized longitudinal and lateral-directional aerodynamic stability and control derivatives for the X-29A aircraft were calculated for altitudes ranging from sea level to 50,000 ft, Mach numbers from 0.2 to 1.5, and angles of attack from -5 deg to 25 deg. Several other parameters were also calculated, including aerodynamic force and moment coefficients, control face position, normal acceleration, static margin, and reference angle of attack. Author

N86-23567*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
GEOMETRIC AND STRUCTURAL PROPERTIES OF A RECTANGULAR SUPERCRITICAL WING OSCILLATED IN PITCH FOR MEASUREMENT OF UNSTEADY TRANSONIC PRESSURE DISTRIBUTIONS
R. H. RICKETTS, J. J. WATSON, M. C. SANDFORD, and D. A. SEIDEL Nov. 1983 19 p refs
(NASA-TM-85673; NAS 1.15:85673) Avail: NTIS HC A02/MF A01 CSCL 01A

Wind-tunnel tests to measure unsteady aerodynamic data in the transonic region have been completed on an aspect ratio 2.0 rectangular wing with a supercritical airfoil. The geometric and structural properties of the wing are presented. (Other references contain the measured aerodynamic data.) Both measured and design airfoil coordinates are presented and compared. In addition, measured wing bending and torsional stiffness distributions and some trailing-edge flexibility influence coefficients are presented. Author

N86-23568*# Analytical Methods, Inc., Redmond, Wash.
INVESTIGATION TO ADVANCE PREDICTION TECHNIQUES OF THE LOW-SPEED AERODYNAMICS OF V/STOL AIRCRAFT
B. MASKEW, D. STRASH, J. NATHMAN, and F. A. DVORAK Feb. 1985 153 p refs
(Contract NAS2-11169)
(NASA-CR-166479; NAS 1.26:166479) Avail: NTIS HC A08/MF A01 CSCL 01A

A computer program, VSAERO, has been applied to a number of V/STOL configurations with a view to advancing prediction techniques for the low-speed aerodynamic characteristics. The program couples a low-order panel method with surface streamline calculation and integral boundary layer procedures. The panel method--which uses piecewise constant source and doublet panels-includes an iterative procedure for wake shape and models boundary layer displacement effect using the source transpiration technique. Certain improvements to a basic vortex tube jet model were installed in the code prior to evaluation. Very promising results were obtained for surface pressures near a jet issuing at 90 deg from a flat plate. A solid core model was used in the initial part of the jet with a simple entrainment model. Preliminary representation of the downstream separation zone significantly improve the correlation. The program accurately predicted the pressure distribution inside the inlet on the Grumman 698-411 design at a range of flight conditions. Furthermore, coupled viscous/potential flow calculations gave very close correlation with experimentally determined operational boundaries dictated by the onset of separation inside the inlet. Experimentally observed degradation of these operational boundaries between nacelle-alone tests and tests on the full configuration were also indicated by the calculation. Application of the program to the General Dynamics

STOL fighter design were equally encouraging. Very close agreement was observed between experiment and calculation for the effects of power on pressure distribution, lift and lift curve slope. Author

N86-23569*# Rockwell International Science Center, Thousand Oaks, Calif.
NONLINEAR POTENTIAL ANALYSIS TECHNIQUES FOR SUPERSONIC-HYPERSONIC AERODYNAMIC DESIGN
V. SHANKAR and W. C. CLEVER 7 Mar. 1984 57 p refs
(NASA-CR-172299; NAS 1.26:172299) Avail: NTIS HC A04/MF A01 CSCL 01A

Approximate nonlinear inviscid theoretical techniques for predicting aerodynamic characteristics and surface pressures for relatively slender vehicles at supersonic and moderate hypersonic speeds were developed. Emphasis was placed on approaches that would be responsive to conceptual configuration design level of effort. Second order small disturbance and full potential theory was utilized to meet this objective. Numerical codes were developed for relatively general three dimensional geometries to evaluate the capability of the approximate equations of motion considered. Results from the computations indicate good agreement with experimental results for a variety of wing, body, and wing-body shapes. Author

N86-23570# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
VALIDATION OF USAF STABILITY AND CONTROL DATCOM METHODOLOGIES FOR STRAIGHT-TAPERED SWEPTFORWARD WINGS Final Report, 1 Nov. 1980 - 30 Apr. 1984
D. G. SHARPES Jul. 1985 211 p
(Contract AF PROJ. 2403)
(AD-A161876; AFWAL-TR-84-3084) Avail: NTIS HC A10/MF A01 CSCL 20D

A detailed review of USAF Stability and Control Datcom methodologies was conducted to determine their validity for application to straight tapered, sweptforward wing configurations. To the extent possible the format found in the Datcom is repeated in this report. Several methods were modified to enable more accurate coefficient prediction (e.g., Wing Zero-Lift Angle of Attack, Downwash and Yawing Moment due to Yaw Rate) irrespective of sweep sign. At supersonic speeds, the reversibility theorem enabled most methodologies to be used without any modifications to account for sweptforward leading-edge designs. For the methodologies validated, sweptforward-wing estimation results were generally as accurate as the sweptback-wing results presented in the Datcom. Unfortunately, lack of test data prevented validation of several empirical methodologies (e.g., Subsonic High Angle-of-Attack Pitching Moment and Transonic Pitching Moment). No estimation methodologies are proposed in these cases.
Author (GRA)

N86-23571# Oklahoma Univ., Norman. School of Aerospace Mechanical and Nuclear Engineering.
OPTIMIZATION OF TIP STORE MODELING Final Report, May 1983 - Sep. 1984
A. G. STRIZ and S. K. JANG Mar. 1985 105 p
(Contract AF-AFOSR-0184-83)
(AD-A162119; AFOSR-85-1089TR) Avail: NTIS HC A06/MF A01 CSCL 20D

Due to the high cost of performing detailed three-dimensional flutter analyses for aircraft which are carrying large numbers and types of external stores, it is often not economically feasible to include sophisticated store aerodynamics especially when they will not cause significant changes to the flutter results. Thus, the stores are presently often modeled as simple flat plates. This tends to decrease the accuracy of the computed pressure distributions as the spanwise flow field and the wing-body interaction are not represented correctly. In this report, therefore, two methods, a doublet lattice method for subsonic flow and a kernel function method for subsonic and supersonic flow are used for the computation of unsteady pressure distributions and forces on an F-5 wing with a tip mounted launcher/store combination for various store models consisting of simple flat plates, endplated, and axisymmetric bodies. The resulting aerodynamic data are compared to existing experimental and numerical results for the same wing/store combination. The store modeling was optimized for simplicity and accuracy with respect to the aerodynamic forces and pressures. The wing-body interaction was improved without a considerable increase in complexity, i.e., panel number, and thus computational effort. Author (GRA)

N86-23572# Indiana Univ.-Purdue Univ., Indianapolis. School of Engineering and Technology.
A ZONAL APPROACH TO THE DESIGN OF FINITE ELEMENT GRIDS FOR 3-D TRANSONIC FLOWS WITH COMPLEX GEOMETRIES Annual Report, 1 Jun. 1983 - 30 Jun. 1985
A. ECER 30 Jun. 1985 98 p
(Contract F49620-83-K-0034)
(AD-A162168; AFOSR-85-1061TR) Avail: NTIS HC A05/MF A01 CSCL 20D

A block-structured solution scheme is developed for the analysis of three-dimensional transonic flows. The scheme is based on the solution of potential flow equations for individual blocks representing part of the flow field. Based on a previously developed block-structured grid generation scheme, appropriate computational grids are generated for each of the blocks depending on the complexity of the local flow field. The equations are then solved to provide a solution of a large problem in terms of an assembly of smaller problems for each block. Numerical results illustrate the applicability of the method for a three-dimensional flow field around a wing profile (NACA0012). Different block structures are analyzed to demonstrate the robustness and the accuracy of the developed method. Finally a three-dimensional wing-body configuration is analyzed and the results are compared with previously obtained single block solutions. The method is expandable to the solution of Euler and Navier-Stokes equations. It is also suited to be executed in a parallel processing environment. GRA

N86-23573# Boeing Commercial Airplane Co., Seattle, Wash.
COUPLING LINEARIZED FAR-FIELD BOUNDARY CONDITIONS WITH NONLINEAR NEAR-FIELD SOLUTIONS IN TRANSONIC FLOW Annual Report, 1 Jul. 1983 - 1 Feb. 1985
W. S. ROWE and F. E. EHLERS 1 Feb. 1985 82 p
(Contract F49620-83-C-0118)
(AD-A162334; D6-52895; AFOSR-85-1082TR) Avail: NTIS HC A05/MF A01 CSCL 20D

This investigation evaluated the feasibility of coupling linearized far-field finite differencing equations to reduce the size of grid networks required in present transonic flow calculations. A procedural change to an existing finite differencing program involved distributing sources on the solution interface boundary in order to develop the proper far-field outgoing wave boundary condition on a reduced size grid network. Validation of the modification procedure was established for zero thickness airfoils by comparing predicted two-dimensional results with results obtained from an exact procedure. A criterion based on the gradient of the flow field Mach number was developed for use in establishing the minimum size grid network necessary for accurate finite thickness unsteady loading predictions. Acceptable loading predictions were achieved for a nominal 5:1 gridsize reduction ratio with a 40% reduction in computer usage costs. GRA

N86-23575# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ACTA AERODYNAMICA SINICA (SELECTED ARTICLES)
F. ZHUANG, H. ZHANG, G. LING, S. XIUNG, and P. ZHU 5 Dec. 1985 182 p Transl. into ENGLISH from Konggi Donglixue Xuebao (China), no. 4, 1984 p 1-4; 21-33; 41-97
(AD-A162993; FTD-ID(RS)T-0639-85) Avail: NTIS HC A09/MF A01 CSCL 20D

Titles include: Advances in the Study of Separated Flows; Problems in Discrete Vortex Numerical Modelling of Vortex Motion behind a Circular Cylinder; Calculation of Slender Delta Wing with

Leading-edge Separation by Quasi-vortex-lattice Method; Calculation of Flow around Thick Wing with Separation Vortices; Split Coefficient Matrix Difference Method for Supersonic Three-dimensional Flow; Some Characteristics of the FLIC Method and Its Application to Calculation of Pitot Pressure of Dusty-Gas Shock Tube Flow; Experimental Investigation of Flap Turbulent Heat Transfer and Pressure Characteristics in Hypersonic Flow; Laser Doppler Anemometer Measurements for Leading Edge Vortex Core Velocity of a Strake-wing; Experimental Research of Boundary Layer Control Technique for Low Speed Multi-component Airfoils; A Simpler Implicit Method to Solve N-S Equation; Numerical Calculation of Separation Flow over Severely Indented Blunt Body; Implicit Technique for Calculating Separated Base Flow; Computation of Compressible Turbulent Separated Boundary Layer; Inverse Boundary Layer Method for Separated Flow; Wall Lift Interference Corrections in Ground Effect Testing. (Translations; China; Chinese language) GRA

N86-23576# Technische Hochschule, Darmstadt (West Germany). Fachgebeit Aerodynamik und Messtechnik.
INVESTIGATIONS IN THE FLOW FIELD OF AIRFOILS WITH VARIOUS GEOMETRIES IN THE DOMAIN OF HIGH ANGLES OF ATTACK. EXPERIMENTAL INVESTIGATIONS Final Report [UNTERSUCHUNGEN IM STROEMUNGSFELD VON FLUEGELN VERSCHIEDENER GEOMETRIE IM HOHEN ANSTELLWINKELBEREICH. EXPERIMENTELLE UNTERSUCHUNGEN]
W. MOELLER 2 Sep. 1985 111 p refs In GERMAN
(Contract DFG-HA-514/63-2)
(REPT-A-13/85) Avail: NTIS HC A06/MF A01

A measuring system to determine flow fields of airfoils was developed. Pressure distribution measurements and pictures were taken to characterize all flight conditions in the domain of high angles of attack where flow separation phenomena are very important. The developed direct flow field measuring system uses hot-wire anemometry and enables the investigation of three-dimensional separation effects on an arrow wing. The results provide important information about the separation behavior of such wings and fundamentals for the development and testing of theoretical methods to calculate separated wing flow.
Author (ESA)

N86-23862# Tokyo Univ. (Japan).
NUMERICAL SIMULATION OF VORTICES SHED BEHIND A ROTATING WING
N. IZUTSU and H. KANDA (IBM Japan, Ltd.) *In its* Proceedings of the Symposium on Mechanics for Space Flight p 43-50 Mar. 1985 refs Sponsored in part by IBM Japan, Ltd.
Avail: NTIS HC A08/MF A01

The vortices shed behind a 15%-thick, two dimensional elliptic cylinder rotating around its spanwise axis perpendicularly to a uniform flow were numerically analyzed using discrete vortex-blob method. The color coded vorticity distributions in the flow field were displayed in both cases of the forced and autorotation. Moreover, a 16 mm animation movie of it was made to visualize vortex interactions. By means of this color graphic simulation, the merging rearrangement, interaction and splitting of the vortices in the wake flow of a rotating wing were demonstrated making these processes clearly understandable. Author

03

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A86-29872#
CONTROLLED-FLIGHT-INTO-TERRAIN ACCIDENTS DURING UNPUBLISHED-ROUTE RADAR VECTORING
J. M. MCCORMICK, JR. (Air Line Pilots Association, Washington, DC) IN: Symposium on Aviation Psychology, 3rd, Columbus, OH, April 22-25, 1985, Proceedings . Columbus, OH, Ohio State University, 1985, p. 199-206. refs

The present paper is concerned with Controlled-Flight-Into-Terrain (CFIT) accidents involving aircraft operated under Instrument Flight Rules (IFR) in controlled airspace, taking into account Instrument Meteorological Conditions (IMC) and Night Visual Meteorological Conditions (NVMC). As an example for the type of accident being considered, an event is described in which an instrument flight instructor and her student in a single-engine Cessna aircraft impacted mountainous terrain at the 3500-foot level. Attention is given to the guidance of the aircraft with the aid of 'radar vectors', the loss of voice communication between controller and aircraft, and questions concerning a situation which made a flight of five minutes duration in the clouds toward high terrain by an experienced flight instructor possible. It is found that problems can arise because pilots are routinely guided over unpublished 'radar routes'. Interim and long-term solutions to these problems are discussed. G.R.

A86-29936#
AIR TRANSPORT PILOT INVOLVEMENT IN GENERAL AVIATION ACCIDENTS
S. SALVATORE, S. HUNTLEY, and P. MENGERT (DOT, Transportation Systems Center, Cambridge, MA) IN: Symposium on Aviation Psychology, 3rd, Columbus, OH, April 22-25, 1985, Proceedings . Columbus, OH, Ohio State University, 1985, p. 729-739.

The involvement of airline transport pilots (ATPs) and private pilots (PVTs) flying general aviation (GA) aircraft in fatal and nonfatal accidents is investigated. Accident records for GA accidents occurring between 1973-1983 are studied; the data indicate that PVTs were involved in 13,219 nonfatal and 2,454 fatal accidents, and ATPs produced 461 nonfatal and 96 fatal accidents. Analysis of the data reveals that the ATPs comprise 7.5 percent of pilots, but account for only 3 percent of GA accidents while having greater exposure time than PVTs. Accident characteristics, causes, and pilot behaviors which differentiate the two groups are described. It is concluded that ATPs are involved in less GA pilot-induced accidents, less weather-related accidents, and less accidents in traffic patterns than PVTs due to their superior flying skills. I.F.

A86-30097
INVESTIGATION OF AN AIRCRAFT ACCIDENT BY FRACTOGRAPHIC ANALYSIS
R. V. KRISHNAN, S. RADHAKRISHNAN, A. C. RAGHURAM, and V. RAMACHANDRAN (National Aeronautical Laboratory, Bangalore, India) IN: Advances in fracture research (Fracture 84). Volume 5 . Oxford and New York, Pergamon Press, 1986, p. 3677-3684. refs

A Boeing 737 passenger aircraft suffered a mid-air explosion in the front toilet area during a scheduled flight and forced the pilot to make an emergency landing. In that process the aircraft overshot the runway damaging its undercarriage and underside. To determine the primary cause of explosion and its exact location, extensive fractographic examination was carried out on the fragments found near the explosion area. These fragments contained signatures characteristic of explosive fracture. The exact location of these fragments in the original aircraft structure was

identified. It was concluded that the accident was due to a chemical explosion inside the front toilet of the aircraft. By tracing the trajectories of the projectiles flying in various directions following the explosion, the centre of the explosion, i.e., the location of the explosive device in the aircraft was established to be the waste paper receptacle placed under the wash basin. Author

A86-31005#
SURVIVAL OF HELICOPTER ACCIDENTS [SUPERVIVENCIA EN LOS ACCIDENTES DE HELICOPTEROS]
J. A. ROJAS LOZANO (Escuela Tecnica Superior de Ingenieros Aeronauticos, Madrid, Spain) IAA/Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), Oct. 1985, p. 31-36. In Spanish. refs

An evaluation is made of anthropometric factors relevant to the improvement of helicopter crash injury rates, in view of a U.S. Army study of helicopter crashes occurring in 1970-1971 which estimated that as many as 160 fatalities could have been prevented with suitable attention by designers to crash survival criteria. Attention is given to the capacity of the human body for absorption of the impact loads of sudden deceleration; data are presented for the effects of harnesses and the duration and magnitude limits of human resistance to injury by sudden deceleration. O.C.

A86-31011#
ACCIDENT OF THE DC-10 EC-DEG AIRCRAFT AT MALAGA ON SEPTEMBER 13, 1982 [ACCIDENTE DEL AVION DC-10 EC-DEG EN MALAGA EL 13 DE SEPTIEMBRE DE 1982]
IAA/Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), Jan. 1986, p. 24-31. In Spanish.

The present analysis of the abortive takeoff-type accident of a DC-10 at Malaga airport gives attention to the velocity profiles of the aircraft from takeoff to ground impact. A fire followed ground impact. Takeoff abort was initiated by the crew with only 1295 m of runway left beneath the aircraft. On the basis of the data obtained by this analysis, it is recommended that both pilots and other flight crew members be trained to respond to takeoff failures due to causes other than loss of engine power, such as landing gear collapse. O.C.

A86-31324
THE ECONOMICS OF THE NORTH ATLANTIC AIR TRAFFIC SYSTEM
V. W. ATTWOOLL Journal of Navigation (ISSN 0020-3009), vol. 39, Jan. 1986, p. 103-109.

The effects of the meteorological environment and navigational restrictions on the North Atlantic air traffic system are investigated. The use of 12-hour and 24-hour forecasts to plan the proper organized track structure for aircraft to follow over the Atlantic is discussed. Inaccurate forecasting influences the fuel consumption and arrival times of the aircraft. The penalties that result from separation minima imposed by the air traffic control, which are 60 n.m. laterally and 2000 ft vertically, are examined; these limitations cause changes in flight plans and do not permit the optimum performance of the aircraft. Methods of improving the North Atlantic air traffic system, including the use of a composite track system, a reduction in vertical separation form 2000 ft to 1000 ft, and the use of later and more accurate weather forecasts, are described. I.F.

A86-31325
AIRLINES AND THE NEW TECHNOLOGY AIRCRAFT - A DISCUSSION PAPER
G. A. C. GRAY (British Airways, PLC, Hounslow, England) Journal of Navigation (ISSN 0020-3009), vol. 39, Jan. 1986, p. 110-119.

Advances in aircraft technology and crew training procedures are studied. The configuration of the flight deck, new flight instruments and displays, and crew procedures for the new aircraft are described. The required interactions between air traffic control and the flight crew in order to assure the optimum performance of the aircraft are examined. The use of audio visual tutors and flight simulator to train the pilots on the functions of electronic flight instrumentation, automatic flight control, and flight management computers is investigated. The advantages and disadvantages of the digital computation systems are analyzed. Future developments in avionics such as a comprehensive data-link network are discussed. I.F.

A86-31956#
ANATOMY OF A NOISE-ABATEMENT CLIMB
M. A. GARBELL (M.A.G. Consultants, Inc., San Francisco, CA) IN: Inter-noise 85; Proceedings of the Fourteenth International Conference on Noise Control Engineering, Munich, West Germany, September 18-20, 1985. Volume 1 . Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz, 1985, p. 311-314. refs

Noise abatement aircraft climb techniques for the first 10-12 nautical miles of flight are discussed. The basic prerequisites for a safe and efficient climb are reviewed, and the factors controlling the intensity of noise emission at a point on the ground are described along with the standard types of noise-abatement climbs. The effect of meteorological parameters on aircraft noise is summarized, and the quality of the currently available data base on climb procedures and noise abatement is assessed. C.D.

A86-32068
BIODYNAMICS OF PERSONNEL PARACHUTE LANDINGS - A FRESH LOOK AT PARACHUTE DESCENT RATES
D. C. JOHANSON and K. E. WITTENDORFER (U.S. Navy, Naval Weapons Center, China Lake, CA) SAFE Journal, vol. 16, Spring 1986, p. 16-23.

A test program has been established to provide biodynamic data of simulated parachute landings which, when combined with biomechanical data and a computer model, will indicate the safety of various combinations of total speed and angle of impact. This information will then provide more substantial justification into the maximum acceptable velocities for specifications such as MIL-P-85710 and MIL-S-18471. Test facility components include a 59-foot rail assembly which can be adjusted to assume angles from the vertical to the horizontal, a jumper connected to a launch vehicle via a parachute harness and risers, and a velocity-measuring gravity-assisted pulley control system. After obtaining specified steady-state conditions, the subject performs a forward right plf upon ground contact. Data displayed reduced g levels in the four-foot plf, in comparison with a four-foot standup landing, supporting the advantages in performing a plf. Time-dependent quantities of acceleration, delta velocity, body angle, and angulalr rate were plotted, and a viable method of determining relationships between the impact velocity vector and transducer signals has been found. K.K.

A86-32070
EVALUATION OF THE CRASH ENVIRONMENT AND INJURY-CAUSING HAZARDS IN U.S. NAVY HELICOPTERS
J. W. COLTMAN, S. ARNDT (Simula, Inc., Phoenix, AZ), and L. DOMZALSKI (U.S. Navy, Naval Air Development Center, Warminster, PA) SAFE Journal, vol. 16, Spring 1986, p. 44-50. refs

A survey of the crash environment for U.S. Navy helicopters was undertaken to quantify the impact parameters and identify hazards causing major injury. One hundred and eighty-six (186) Flight Mishaps were reviewed for the 10-year period of January 1972 to December 1981. Out of the 186 mishaps reviewed, 154 were judged to be survivable. Accident reconstruction was used to determine the impact parameters for the survivable accidents. Statistical distribution of the important impact parameters, such as pitch, roll, and yaw angle and vertical, horizontal and lateral velocity change, were developed. Also, a hazard analysis was conducted to correlate the major and fatal injuries to the injury-causing hazards mechanisms. Sixteen specific injury-causing hazards were identified. The data developed in this study provides the basis for improving the crashworthiness of the existing helicopter fleet and of future Navy aircraft. Author

A86-33427
MAJOR SHORT-HAUL ROLE SEEN FOR TILT-ROTOR AIRCRAFT
R. F. SPIVEY (Bell Helicopter Textron, Fort Worth, TX) ICAO Bulletin, vol. 41, Feb. 1986, p. 25-28.

An evaluation is made of the prospective impact of tilt-rotor aircraft VTOL operations, in the air taxy and city center-to-city center commuter fields, on airport congestion. The tilt rotor VTOL aircraft envisioned in these performance evaluations is a civilian version of the U.S. Armed Forces' 'JVX', which is in turn a scale-up development of the XV-15 test aircraft. Emphasis is given to the ability of a tilt-rotor aircraft in its commuter airliner function to bypass regional airports and deliver passengers to city centers directly. O.C.

N86-22558*# Ohio State Univ., Columbus. Aeronautical and Astronautical Research Lab.
WIND TUNNEL TESTS OF ROTOR BLADE SECTIONS WITH REPLICATIONS OF ICE FORMATIONS ACCRETED IN HOVER Final Report
J. D. LEE, J. H. BERGER (Fluidyne Engineering Corp., Columbus, Ohio), and T. J. MCDONALD (Fluidyne Engineering Corp., Columbus, Ohio) Mar. 1986 31 p refs
(Contract NAG3-374)
(NASA-CR-175089; NAS 1.26:175089) Avail: NTIS HC A03/MF A01 CSCL 01C

Full scale reproductions of ice accretions molded during the documentation of a hover test program were fabricated by means of epoxy castings and used for a wind tunnel test program. Surface static pressure distributions were recorded and used to evaluate lift and pitching moment increments while drag was determined by wake surveys. Through the range of the tests, corresponding to those conditions encountered in hover and in flat pitch, integration of the pressure distributions showed negligible changes in lift and in pitching moment, but the drag was significantly increased. Author

N86-22559*# Fluidyne Engineering Corp., Columbus, Ohio.
DOCUMENTATION OF ICE SHAPES ACCRETED ON THE MAIN ROTOR OF A UH-1H HELICOPTER IN LEVEL FLIGHT Final Report
M. K. HANSON and J. D. LEE (Ohio State Univ., Columbus) Mar. 1986 14 p refs
(Contract NAG3-374)
(NASA-CR-175088; NAS 1.26:175088) Avail: NTIS HC A02/MF A01 CSCL 01C

Icing tests were conducted on a UH-1H helicopter in level flight behind a spray tanker near Duluth, Minnesota, during the winter of 1983-84 as part of the joint NASA/Army HIFT program. On landing, the ice formations on the main rotor were documented by casting a set of ten-inch molds on the blade using a Dow-Corning silicone rubber compound which was initially liquid at sub-freezing temperatures. Such documentation was accomplished for eight flights in which the temperature ranged from -11 C to -22 C and the in-cloud flight times ranged from 5 to 9 minutes. Author

N86-22560# Aeronautical Research Labs., Melbourne (Australia).
THE AUSTRALIAN IMPLEMENTATION OF AMDAR/ACARS AND THE USE OF DERIVED EQUIVALENT GUST VELOCITY AS A TURBULENCE INDICATOR
D. J. SHERMAN Oct. 1985 42 p refs
(AR-004-51; ARL-STRUC-R-418) Avail: NTIS HC A03/MF A01

AMDAR is a system of measuring wind speed, wind direction, air temperature and an indication of turbulence from INS equipped transport aircraft in flight. These data are transmitted by radio to the meteorological system. This report outlines the Australian AMDAR system presently coming into service on the Boeing 767 aircraft in the Ansett fleet. The data are telemetered using ACARS and the SITA/AIRCOM network of ground stations. Particular attention is paid to the indicator of turbulence. Because an aircraft flying through a given gust may encounter very different vertical accelerations depending on aircraft mass, airspeed and altitude, it is proposed that the AMDAR system compute the derived equivalent gust velocity from the aircraft acceleration and other parameters, and that this is used as an indicator of turbulence. Such an indicator has the additional advantage that it is more use for climatological studies of turbulence occurrence than simpler indicators such as the aircraft vertical acceleration. Severe turbulence corresponds to derived equivalent gust velocities in excess of g m/s. Author

N86-23577*# Sverdrup Technology, Inc., Cleveland, Ohio.
ANALYTICAL DETERMINATION OF PROPELLER PERFORMANCE DEGRADATION DUE TO ICE ACCRETION Final Report
T. L. MILLER Apr. 1986 138 p refs
(Contract NAS3-24105)
(NASA-CR-175092; NAS 1.26:175092) Avail: NTIS HC A07/MF A01 CSCL 01C

A computer code has been developed which is capable of computing propeller performance for clean, glaze, or rime iced propeller configurations, thereby providing a mechanism for determining the degree of performance degradation which results from a given icing encounter. The inviscid, incompressible flow field at each specified propeller radial location is first computed using the Theodorsen transformation method of conformal mapping. A droplet trajectory computation then calculates droplet impingement points and airfoil collection efficiency for each radial location, at which point several user-selectable empirical correlations are available for determining the aerodynamic penalities which arise due to the ice accretion. Propeller performance is finally computed using strip analysis for either the clean or iced propeller. In the iced mode, the differential thrust and torque coefficient equations are modified by the drag and lift coefficient increments due to ice to obtain the appropriate iced values. Comparison with available experimental propeller icing data shows good agreement in several cases. The code's capability to properly predict iced thrust coefficient, power coefficient, and propeller efficiency is shown to be dependent on the choice of empirical correlation employed as well as proper specification of radial icing extent. Author

N86-23578# Luftfahrt-Bundesamt, Brunswick (West Germany). Flugunfalluntersuchungsstelle.
RESULTS OF THE TECHNICAL INVESTIGATION OF ACCIDENTS DURING THE OPERATION OF GERMAN AIRCRAFT AT HOME AND ABROAD, AND OF FOREIGN AIRCRAFT IN GERMANY Annual Report, 1982 [ERGEBNISSE DER FACHLICHEN UNTERSUCHUNG VON UNFAELLEN BEI DEM BETRIEB DEUTSCHER LUFTFAHRZEUGE IM IN- UND AUSLAND SOWIE AUSLAENDISCHE LUFTFAHRZEUGE IM INLAND]
Jul. 1985 119 p In GERMAN
Avail: NTIS HC A06/MF A01

All aircraft accidents since January 1, 1973 were analyzed. Standardized tables giving a general overview are presented. Special statistics can be provided, for which selection criteria and table parameters can be freely chosen. Author (ESA)

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A86-30314#
FLIGHT TEST OF A VELOCITY AUGMENTED STRAPDOWN NAVIGATION SYSTEM LHN-81
H.-J. HOTOP, H.-P. ZENZ (DFVLR, Institut fuer Flugfuehrung, Brunswick, West Germany), and M. KLEINSCHMIDT (LITEF-Litton Technische Werke, Freiburg im Breisgau, West Germany) IN: Symposium Gyro Technology 1985; Proceedings of the Symposium, Stuttgart, West Germany, September 24, 25, 1985 . Stuttgart/Duesseldorf, Universitaet Stuttgart/Deutsche Gesellschaft fuer Ortung und Navigation, 1985, p. 16.0-16.21. refs

Helicopter-based flight tests have been conducted for the LHN-81 hybrid navigation system, which is of the inertial strapdown type and is augmented by a Doppler velocity sensor and a magnetic heading sensor; performance comparisons have been made with the existing LTN-90 inertial navigation system, whose accuracy had been increased by means of an offline algorithm. The position accuracy of the LHN-81 is 1.3 percent in 95 percent of all events. For a nap-of-the-earth flight profile with helicopter dynamics, the 95-percent CEP accuracy in 15 min of flight time was less than 100 m. O.C.

A86-30358
GRAPHIC SIMULATION FOR AIR TRAFFIC CONTROL DEVELOPMENT
E. S. STEIN (FAA Technical Center, Atlantic City, NJ) IN: 1985 Summer Computer Simulation Conference, Chicago, IL, July 22-24, 1985, Proceedings . San Diego, CA, Society for Computer Simulation, 1985, p. 653-656. refs

In air traffic control, graphic simulation means employing equipment currently available to provide a two-dimensional representation of the three-dimensional airspace using a preplanned 'canned' air traffic scenario. The background history of the use of graphic simulation in aviation is examined, taking into account the use of situational graphics to evaluate potential pilots' abilities to relate aircraft orientation to instrument displays. In developments toward higher levels of automation, one family of tools is AERA, the automated en route air traffic control program. Aspects of AERA graphic simulation are examined, giving attention to the problem, the laboratory, the flight data display, the radar planned view display, and an overview of the graphic simulation. The employment of graphic simulation is also discussed. G.R.

A86-30488
KNOWLEDGE-BASED APPROACH TOWARD DEVELOPING AN AUTONOMOUS HELICOPTER SYSTEM
J. F. GILMORE and A. C. SEMECO (Georgia Institute of Technology, Atlanta) Optical Engineering (ISSN 0091-3286), vol. 25, March 1986, p. 415-427. Research supported by the Georgia Institute of Technology. refs

This paper presents a description of the Autonomous Helicopter System (AHS) which is currently being implemented in the Georgia Tech Research Institute. It is pointed out that autonomous vehicles provide a mechanism for removing humans from modern-day battlefields while not impacting the tactical capabilities of the battle force. Civilian applications for such a device include the investigation of hazardous areas, search over large areas, and the monitoring of large facilities. The AHS consists of three sections. The vision section is the sensor processing component of the AHS. Attention is given to image segmentation, region classification, scene analysis, visual model construction, scene matching, and threat location and coverage. The goal of the planning section is to produce an executable plan of action which can be implemented by the control section. The goal of the control section is also discussed, and an autonomous helicopter mission is described. G.R.

A86-31004#
THE PRIVATE ENTERPRISE FACTOR IN REGIONAL AIRLINES [LA GESTION EMPRESARIAL EN LAS CIAS - AEREAS DE TERCER NIVEL]
R. FERNANDEZ (Escuela Tecnica Superior de Ingenieros Aeronauticos, Madrid, Spain) IAA/Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), Aug.-Sept. 1985, p. 9-20. In Spanish.

An economic and regulatory evaluation is made of the prospects for Spanish regional airlines, with reference to such factors as competition, political climate, aircraft acquisition and maintenance costs, personnel management, and direct and indirect cost structures. Extensive comparisons are made with similar operations in the U.S. and Europe. The importance of debt structures in the financing of such airline operations is emphasized. O.C.

A86-31006#
AERIAL NAVIGATION [NAVEGACION AEREA]
E. MUNOZ DE LUNA (Direccion General de Aviacion Civil, Centro de Control de Sevilla, Seville, Spain) IAA/Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), Nov. 1985, p. 12-21. In Spanish.

The development status and organizational structure of Spain's ATC system are discussed, with attention to the degree and effectiveness of ATC automation. The features and capabilities of communications, surveillance radar, and navigation aids subsystems are noted. The Spanish ATC system's primary installations are at Paracuellos, Barcelona, Palma, Las Palmas, and Sevilla. Modernization efforts currently underway and planned are identified. O.C.

A86-31007#
CONSIDERATIONS ON THE INFLUENCE OF POSITIONING ON THE QUALITY OF GP ILS INFORMATION [CONSIDERACIONES SOBRE LA INFLUENCIA DEL EMPLAZAMIENTO EN LA CALIDAD DE LA INFORMACION GP ILS]
E. LALLEMAND IAA/Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), Nov. 1985, p. 29-33. In Spanish.

A ground position instrument landing system (GP ILS) radiates horizontal polarization energy signals at 329.3-335.0 MHz in order to furnish elevation data to aircraft during landing approaches. This signal determines the modulation amplitude of two audible tones over the UHF channel. The consequences for this ILS data of the position (spatial distribution) of the signals is presently treated in light of the Fresnel zones created by this system's antennas. O.C.

A86-31008#
TRENDS IN THE DESIGN OF AIRFIELD RADARS [TENDENCIAS EN EL DISENO DE RADAR PARA AERODROMOS]
D. J. SIMMONS (Plessey Co., PLC, Ilford, England) IAA/Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), Nov. 1985, p. 35-42. In Spanish.

Attention is given to the radar system requirements of civilian and military airfields, with emphasis on the spurious effects of background clutter radar echoes generated by terrain, rain, etc. A performance comparison is made between magnetron, klystron, and traveling wave tube S-band radar designs with respect to such factors as pulse compression capability, sector suppression, stability, operational flexibility, and peak power. A detailed discussion is presented of the performance of the 'Watchman' primary radar. O.C.

A86-31009#
RESTRICTIONS ON THE DISPOSITIONS OF NAVIGATION AIDS [RESTRICCIONES EN EL ENTORNO DE LAS AYUDAS A LA NAVEGACION]
R. BENITEZ IAA/Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), Dec. 1985, p. 9-15. In Spanish.

Restrictions on the positioning and radiation pattern of such airport approach navigation aids as the microwave landing system (MLS) and older ILSs are undertaken in order to safeguard their radiation patterns, without obstruction of their radiation energy, thereby maximizing airport security, reliability of operations, and efficiency. A detailed discussion is presented concerning navigation aid antenna placement, aircraft landing approach relationships to navigation aid coverage, and a projected schedule for the transition from ILS systems to the state-of-the-art MLS. O.C.

A86-31323
NAVIGATION IN AERIAL COMMERCE
J. E. D. WILLIAMS (Institute of Navigation, Annual General Meeting, 39th, London, England, Oct. 23, 1985) Journal of Navigation (ISSN 0020-3009), vol. 39, Jan. 1986, p. 1-16. refs

Developments in air navigation are reviewed. The objectives of navigation are quickness, regularity, fuel conservation, low wear and tear, maximum payload, comfort, safety, and noise abatement. The advances in navigation technique from average drift path, to altimeter flying, and to the present inertial navigation systems are described and examples are provided. The limitations on navigation imposed by air traffic control in order to insure safety, and the need to have a unified management for air traffic control are examined. I.F.

A86-32078#
INSTRUMENTATION SYSTEM FOR REAL TIME NAVIGATION SYSTEM PERFORMANCE ASSESSMENT
G. LUI-KWAN (Boeing Military Airplane Co., Seattle, WA) and D. E. ATKINSON (USAF, Wright-Patterson AFB, OH) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 7 p.
(AIAA PAPER 86-9731)

The Navigation Accuracy Instrumentation System (NAIS) was designed as a real time navigation instrumentation system for the evaluation of the B-1B aircraft's navigation suite performance. Differences in position and velocity between NAIS and the Inertial Navigation Units aboard the B-1B are provided to the operator for in-flight evaluation of the navigation system's performance. These data are also recorded for postflight evaluation of test flights. Attention is given to the role of NAIS in the evaluation of the B-1B Navigation and Weapons Delivery system performance. O.C.

A86-32080#
FLIGHT PATH MEASUREMENT OF HELICOPTERS USING A STRAP-DOWN NAVIGATION SYSTEM
H. GLOECKL and A. GRUENEWALD (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 7 p.
(AIAA PAPER 86-9733)

A strapdown navigation system is developed to measure helicopter flight path for flight certification at any location and without the use of special ground equipment. The required accuracy is achieved through high accuracy sensors, which help minimize acceleration errors, and the avoidance of unnecessary flight maneuvers in flights limited to two minutes. Measurements of attitude, velocity, distance, and altitude were made for translatory movements, Cat A and B start and landing profiles, H/V tests (upper point and knee point), and Cat A vertical takeoff profiles from a platform. Instantaneous measurement accuracy checking is possible at the end of each test. R.R.

A86-32127#
F-16 RADAR DATA ACQUISITION AND ANALYSIS
S. G. DI DOMENICO (USAF, Flight Test Center, Edwards AFB, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 6 p.
(AIAA PAPER 86-9798)

A system for the quick turn around of F-16 AN/PG-68 Doppler radar data for qualitative and quantitative review is presented. A quick functional integrity evaluation is provided by video taping of the heads-up display and the radar scope during the mission. A Radar Diagnostic Instrumentation Pod (RDIP) records the Display Multiplexed Bus, the Digital Bus, and the Programmable Signal Processor Bus to collect the quantitative physical mission data. The RDIP consists of a recorder, a record buffer, and a control panel. The Automated Digital Data Reduction Support System (ADDRESS) is a VAX resident interactive system which performs data retrieval and analysis through FORTRAN and Instrumentation Data Extraction and Analysis Language (IDEAL) programs. R.R.

A86-32131#
RASP - A SYSTEM GENERATING VERY ACCURATE POSITION MARKERS DURING FLIGHT TESTING
O. B. M. PIETERSEN (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 7 p.
(AIAA PAPER 86-9802)

This paper describes a system with which the one-dimensional position of an aircraft in the flight direction can be determined with a very high accuracy. The ground- and airborne parts of the system are discussed, as well as the factors which influence the accuracy. It is shown that the attainable accuracy is in the order of 0.3 meter if the aircraft flies at low altitude above the centerline of the runway. If the aircraft taxies, a situation often occuring during take-off and landing trials, the accuracy is better than 0.1 meter. Author

A86-32142#
PERFORMANCE CHARACTERISTICS OF TRANSPONDER-AIDED VERSUS GPS-AIDED INERTIAL NAVIGATION SYSTEMS
C. O. SMITH, JR. and D. J. BIEZAD (USAF, Institute of Technology, Wright-Patterson AFB, OH) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 9 p. refs
(AIAA PAPER 86-9817)

By combining excellent short term inertial navigation system (INS) performance with the long term performance benefits of the Global Positioning System (GPS) a beneficial synergistic effect can be obtained, and integrated GPS-INS (IGI) covariance analysis packages have been employed to develop high order error models. This paper is concerned with a modification of an IGI simulation program, taking into account the necessity to improve the Completely Integrated Reference and Instrumentation System (IRIS). This improvement is required to test the extremely accurate navigation systems now built by industry. A covariance analysis showed that the CIRIS model aided by GPS performed much better than the CIRIS alone, as expected, but not substantially better than the GPS/INS model with the ground transponders eliminated. For this reason, the potential exists to increase reference trajectory accuracy while simultaneously decreasing problems in routing, logistics, reliability, and maintainability of the transponders. G.R.

A86-32578
PERFORMANCE ANALYSIS OF AIRBORNE PULSE DOPPLER RADAR
P. E. HOLBOURN and A. M. KINGHORN (Ferranti Defence Systems, Ltd., Edinburgh, Scotland) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 12-16.

Design of a satisfactory radar waveform requires that a number of design trade-offs be considered. It is thus an essential part of the design process to make parametric analyses of detection performance. This paper presents the unique features of a computer program that has been developed to perform such calculations for high and medium PRF systems. Clutter levels are computed in all ambiguous range-doppler cells for a variety of flight geometries and ground clutter models. The effects of receiver eclipsing, sidelobe clutter and mainbeam clutter are included. Target detectability is calculated for all values of range and Doppler within a specified envelope. These results are expressed graphically in the form of a blindzone diagram. The obscuration effects of clutter are expressed as a clutter loss. Blindzone diagrams for notional high and medium PRF systems are presented. The variation in performance of a medium PRF system to radar altitude and transmitter peak power is investigated. Author

A86-32579
EFFICIENT, CLOSED-FORM COMPUTATION OF AIRBORNE PULSE-DOPPLER RADAR CLUTTER
J. K. JAO and W. B. GOGGINS (MIT, Lexington, MA) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 17-22. DARPA-sponsored research. refs

Closed-form expressions are derived for airborne pulse-Doppler radars to calculate the ground clutter of a range-Doppler cell under that flat earth assumption. These expressions enable accurate and efficient computation of both radar sidelobe and main lobe clutter for an arbitrary combination of radar pulse-Doppler waveform and low altitude flight configurations as defined by platform speed and dive angle. The results should be useful in the simulation and evaluation of airborne radar performance. Author

A86-32581
ADVANCES IN SECONDARY SURVEILLANCE RADAR SYSTEMS
R. J. W. SCLATER (Marconi Radar Systems, Ltd., Chelmsford, England) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 29-33.

The features of modern monopulse secondary surveillance radar (SSR) system, called Messenger, are discussed. The structural details of the system, including a new antenna design, the interrogator-responser, the decoder, the plot former, and plot processor, are described. The monopulse SSR, which requires only a single reply to obtain target azimuth, overcomes the disadvantages of the fruiting and the high number of lost replies encountered by the conventional SSR. In addition, a monopulse SSR can operate in a stand-alone configuration and can be upgraded to Mode S. Diagrams and schemes are included. I.S.

A86-32601
A RADAR ANALYSIS PROGRAM FOR EVALUATING AND MONITORING PRIMARY AND SECONDARY RADAR SYSTEMS
T. BERGENSTOFF, P. R. CLAUSEN, and F. THOMSEN (Royal Danish Air Force, Vedbaek, Denmark) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 146-150.

This paper describes a Radar Analysis Program for evaluation and monitoring of a Radar System. The program is a general purpose facility for all Radar System containing a Primary and a Secondary radar. The program only requires data from the extractors of the Primary and Secondary Radar. The program has facilities for evaluating the performance of individual beams in 3 Dimensional Radar Systems and height accuracy of Height Finders using IFF mode C informations. The program evaluates the radar performance by analyzing the association of Primary and Secondary Plots of targets of opportunity. This method drastically reduces expenses to Test Flights and permits a continuous quality monitoring of a Radar System. The program has been used successfully for several years for monitoring and evaluating Danish military and civilian Air Traffic Radar Systems. Author

A86-32616
PARAMETERS OF A DEDICATED WEATHER RADAR FOR TERMINAL AIR NAVIGATION, TRAFFIC CONTROL AND SAFETY
P. R. MAHAPATRA (Indian Institute of Science, Bangalore, India) and D. S. ZRNIC (NOAA, National Severe Storms Laboratory, Norman, OK) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 235-240. refs

The interservice NEXRAD Doppler weather radar system, which is under development and proving, is expected to significantly aid in fulfilling FAA's projected aviation weather observation needs in the enroute sector. However, there are questions about its adequacy for the highly dense and dynamic operations ocurring in terminal areas. The constraints arise both from its basic design parameters as dictated by its multi-use role and from its location as part of a national grid. There is need for dedicated terminal area weather radars, especially at large and busy airports. For economy and faster implementation, it is desirable to use as much of NEXRAD hardware and software as possible in these terminal area radars, and only modify the operating parameters to suit dedicated terminal area operation. This paper provides the outline for choice of parameters for such a role and indicates a possible set of parameters. Author

A86-32626* General Electric Co., Philadelphia, Pa.
SPACE BASED RADAR APPLICATION TO AIR TRAFFIC CONTROL
W. J. CAIME (General Electric Co., Space Systems Div., Valley Forge, PA) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 312-321. NASA-supported research. refs

Future control of increasing air traffic on international routes will require significant advances in techniques employed. Development is underway, but at this time does not include addition of radar coverage of vast areas of oceanic traffic. This paper addresses the potential for a space-based radar to provide detection and track of aircraft in future traffic scenarios. Factors that must be considered in further tradeoff and concept optimization are discussed. These include: (1) satellite constellation characteristics and associated coverage, (2) efficient use of available energy in track-while-scan strategies, (3) development of tracker approaches to accommodate inherent system constraints, and (4) the application of transponders to assist in dense traffic environments. The analysis assumes the continued development and availability of technology required for high spacecraft power systems (hundreds of kilowatts), and for radar subclutter visibility. Author

A86-32627
SPACE-BASED BISTATIC RADAR - OPPORTUNITY FOR FUTURE TACTICAL AIR SURVEILLANCE
P. K. LEE and T. F. COFFEY (Mitre Corp., Bedford, MA) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 322-329. USAF-supported research. refs

A space-based bistatic radar (SBBR) in geostationary orbit would be useful for future tactical air surveillance. It should be technically feasible to develop such a radar by the mid-1990's, at which time several critical technologies will have reached maturity for the application. This paper presents a conceptual design of an SBBR and a rough estimate of the gross weight of the space segment, based on the projected technologies. Author

A86-32631
RAID COUNT BY AUTOCORRELATION
K. J. HAMMERLE (Boeing Aerospace Co., Seattle, WA) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 350-354.

It has been hypothesized that a radar can accomplish an aircraft raid count, despite the efforts of an escort jammer, if an autocorrelation operation is performed on the received jammer signal. The concept is based on the assumption that a significant amount of jammer energy is scattered into the 'victim' radar receiver by reflection from the 'quiet' aircraft being escorted and that this energy may be detected by autocorrelating the total signal received at the victim radar receiver. This study presents a theoretical analysis of the concept. Equations, which include all pertinent variables, are derived to define the volume of space surrounding the jammer in which quiet aircraft may be detected. Detection contours are plotted for certain specific cases. Author

A86-32635
THE DESIGN, CONSTRUCTION AND EARLY TRIALS OF A NOVEL AIRBORNE SURVEILLANCE RADAR
J. G. SCHOENENBERGER and P. D. L. WILLIAMS (Racal-Decca Advanced Development, Ltd., Walton-on-Thames, England) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 372-377. refs

Attention is given to a novel airborne surveillance radar that originated in a conventional pulse radar carried under a variety of test aircraft and which was then upgraded to SLAR equipment incorporating a bandwidth processor for the real time recording of images on an inexpensive audio tape deck. Ocean surface imagery of reasonable quality has been obtained by these means. The system is expected to be useful in searches for patterns of shipping and features such as oil slicks and thermal currents in disturbed water. O.C.

A86-32640
MULTIRADAR TRACKING IN THE NEW ATC SYSTEM AT MAZATLAN (MEXICO) AREA CONTROL CENTER
B. FURCOLO, S. PARDINI, and R. PELAGATTI (Selenia S.p.A., Rome, Italy) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 403-409.

The multiradar tracking system for the Flight Information Region of Mazatlan integrates ATC radars located in western Mexico. Local tracking data are sent after suitable conversion to a central data processing center, which combines the data to generate a single multiradar track for each target. The distributed intelligence system architecture employed eases the workloads of the central processor. New solutions have been adopted for the track-combination algorithm which take into account the accuracy of the cooperating radars, target behavior, and the time of the local track detection. O.C.

A86-32823
OPERATIONAL ACCEPTABILITY OF 2.4 KBPS SPEECH FOR TACTICAL COMMUNICATIONS
H. SCHECTER (Support Systems Associates, Inc., Lexington, MA) and J. TIERNEY (MIT, Lexington, MA) IN: MILCOM '85 - Military Communications Conference, Boston, MA, October 20-23, 1985, Conference Record. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 171-175. USAF-sponsored research. refs

This paper describes a series of tests aimed at estimating the operational acceptability of 2.4 kbps LPC speech in high acoustic noise, tactical combat environments. F-15 fighter pilots and E3A (AWACS) controllers, operating in their normal acoustic environments, ran simulated combat missions by communicating via a 2.4 kbps test channel. They then 'graded' the channel by means of a brief questionnaire. Three LPC algorithms (with DRT scores of 71, 75 and 80 percent) were used. The results, although not definitive, suggest that purposeful users will accept lower intelligibility than vocoder designers might expect. The results also indicate a need to examine the effect of listeners' acoustic noise level on intelligibility scores. Author

A86-32824
ASSESSING THE INTELLIGIBILITY AND ACCEPTABILITY OF VOICE COMMUNICATION SYSTEMS
R. L. PRATT (Royal Signals and Radar Establishment, Malvern, England) IN: MILCOM '85 - Military Communications Conference, Boston, MA, October 20-23, 1985, Conference Record. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 176-180.

Methods of assessing the intelligibility and acceptability of voice communication systems are examined. The procedures for the diagnostic rhyme test (DRT) are described. The speech-to-noise ratio data obtained from the DRT are analyzed; the DRT produces intelligibility scores. The utilization of flight simulator sofware packages to estimate the acceptability of voice communication systems is discussed. A comparison of DRT scores and sofware data evaluates the applicability of the communication system. I.F.

A86-32925#
FAA AIR TRAFFIC CONTROL PROGRAM MANAGEMENT TECHNOLOGY APPLICATIONS
H. E. GARTRELL, D. A. SABESKY, and P. E. FITZGERALD, JR. IN: Man's permanent presence in space; Proceedings of the Third Annual Aerospace Technology Symposium, New Orleans, LA, November 7, 8, 1985 . New Orleans, LA, American Institute of Aeronautics and Astronautics, 1985, 19 p.
(Contract DOT-FA01-84-C-00017)

The program management technology software tools and state of art processes used by the FAA's National Airspace System (NAS) are identified. The reasons for NAS, and design drivers which impel its improvement, and the main categories of its 90 projects are reviewed. The Air Traffic Control Element, Ground-to-Air Element, Interfacility Communication Element, and Maintenance and Operations Support Element of the NAS are described, and its Program Management System is discussed. C.D.

N86-22566# Joint Publications Research Service, Arlington, Va.
CHIEF ON UNFAVORABLE YEAR FOR SOVIET AIR TRAFFIC CONTROL
V. SHELKOVNIKOV *In its* USSR Report: Transportation (JPRS-UTR-86-004) p 1-4 12 Mar. 1986 Transl. into ENGLISH from Vozdushnyy Transport (Moscow, USSR), 12 Dec. 1985 p 2
Avail: NTIS HC A05/MF A01

Careful selection and training of air traffic controllers are discussed. The interaction process between traffic services and ground services and improvement of aircraft traffic flow planning system to raise the quality of air traffic control are emphasized. The necessary continuation of finding ways to raise flight safety in air traffic control is reiterated. Human factors in traffic service are considered. E.A.K.

N86-23580 Department of the Air Force, Washington, D.C.
GLIDE SLOPE INDICATOR SYSTEM Patent
I. S. WYATT and H. L. TASK, inventors (to Air Force) 19 Nov. 1985 6 p Supersedes AD-D010173
(AD-D012077; US-PATENT-4,554,543;
US-PATENT-APPL-SN-473392; US-PATENT-CLASS-340-948)
Avail: US Patent and Trademark Office CSCL 01E

A glide slope indicator system in which light from an incoming aircraft's landing light is shaped by spherical/cylindrical lens combination into a line image which strikes a linear photodiode array. By determining which photodiode in the array the center of the line image strikes, the glide slope angle can be determined. An appropriate signal is communicated to the pilot via a pair of indicator lights mounted on the runway depending upon whether the aircraft is above, below or on the desired glide slope angle. GRA

N86-23581# IIT Research Inst., Annapolis, Md.
THE IMPACT OF A TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM ON THE AIR TRAFFIC CONTROL RADAR BEACON SYSTEM AND THE MODE S SYSTEM IN THE LOS ANGELES BASIN Final Report, 15 Jan. 1981 - 15 Jul. 1984
May 1985 133 p refs Prepared in part for Electromagnetic Compatability Analysis Center, Annapolis, Md.
(Contract F19628-80-C-0042)
(FAA-PM-84-30; ECAC-PR-84-003) Avail: NTIS HC A07/MF A01

An analysis was performed to predict the impact of the Traffic Alert and Collision Avoidance System (TCAS) on the performance of selected air traffic control and surveillance systems in the Los Angeles Basin. The predictions involved the impact of minimum TCAS II (TCAS II M) on both the Air Traffic Control Radar Beacon System (ATCRBS) interrogator at Long Beach, and a hypothetical Mode S sensor at Los Angeles (LAX-4), as well as the impact of the combined TCAS I and TCAS II M signal environment on the Long Beach ATCRBS interrogator. These predictions were made using a hypothetical peak Los Angeles Basin airborne deployment and subsets of that deployment. Author

N86-23582# Lear Siegler, Inc., Grand Rapids, Mich.
PRELIMINARY HAZARD ANALYSIS FOR SELF-CONTAINED NAVIGATION SYSTEM
J. T. REEVES 4 Oct. 1985 18 p
(Contract F09603-85-C-1224)
(AD-A161883; MISC-2037) Avail: NTIS HC A02/MF A01 CSCL 17G

This document constitutes the Preliminary Hazard Analysis (PHA) for the C-130 Self-Contained Navigation System (SCNS) installation. It provides an initial risk assessment of the SCNS installation. The purpose of the PHA is to identify safety critical areas, evaluate hazards, and identify the safety design criteria to be used. The items covered in this analysis are to be used during the design phase and trade-off study period to prevent unsafe concepts, designs, or oversights that could lead to incorporation of hazards in the hardware, the system operation, handling, and maintenance. The scope of this analysis for Data Item 0103 is limited to the SCNS installation task A-kit components (viz wiring harness, brackets, racks, control panels, relay boxes, circuit breakers), B-kit components (e.g., ICDUs, BICU, DVS, INU), and the physical interfaces with existing equipment (e.g., CADC or Sensors, Radar, Air Data Sensors). These items will be analyzed in respect to safe installation, safe hardware, and safe usuage (e.g., installation, removal, in-place test, and handling). GRA

N86-23583# Air Force Armament Lab., Eglin AFB, Fla.
PROCEEDINGS OF THE 12TH BIENNIAL GUIDANCE TEST SYMPOSIUM HELD AT HOLLOMAN AFB, NEW MEXICO ON 22-24 OCTOBER 1985, VOLUME 1
K. S. MORGAN, P. ROMANOWSKI, L. VALLOT, G. STEIN, and D. ENNS 15 Oct. 1985 252 p Symposium held at Holloman AFB, N. Mex., 22-24 Oct. 1985
(AD-A161996; AD-TR-85-54-VOL-1) Avail: NTIS HC A12/MF A01 CSCL 17G

These proceedings contain papers which were presented at the Twelfth Biennial Guidance Test Symposium. This symposium, hosted by the Central Inertial Guidance Test Facility, Holloman Air Force Base, New Mexico on 22 to 24 Oct. 1985, was directed toward the exchange of information, stimulation of new ideas, and discussion of current techniques associated with the development and evaluation of inertial guidance and navigation systems. The papers presented included such topics as new test and calibration techniques for accelerometers and ring laser gyros, advances in flight reference systems, new test equipment, and new software developments. Papers presented in the classified portion of the symposium are published as Volume 2. Critical technology papers are published as Volume 3. Author (GRA)

N86-23584# Department of the Navy, Washington, D. C.
AN APPARATUS FOR AND A METHOD OF DETERMINING COMPASS HEADINGS Patent Application
D. G. JABLONSKI, inventor (to Navy) 24 Jun. 1985 12 p
(AD-D012051; US-PATENT-APPL-SN-748248) Avail: NTIS HC A02/MF A01 CSCL 17C

A compass system and method incorporating a global positioning system (GPS), such as the NAVSTAR/GPS multisatellite system, is configured to acquire accurate compass heading information without being affected by magnetic anomalies and without being dependent on the elapsed time since a previous position fix. The compass system comprises, inter alia, two antenna/preamplifiers located, for example, fore and aft a ship or aircraft separated by a predetermined distance d. A microprocessor/minicomputer portion of the system causes an electronic coaxial switch to switch a GPS receiver between the two antenna/preamplifiers automatically thereby measuring their absolute positions. The microprocessor/minicomputer computes and displays on a display unit a compass heading based on the knowledge of the absolute positions of the antenna/preamplifiers and the distance d there between. GRA

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A86-30090
THE APPLICATION OF FRACTURE MECHANICS METHODOLOGY TO THE DAMAGE TOLERANCE ANALYSIS OF THE BOEING 757 AIRPLANE
S. RAO VARANASI (Boeing Commercial Airplane Co., Seattle, WA) IN: Advances in fracture research (Fracture 84). Volume 5 . Oxford and New York, Pergamon Press, 1986, p. 3469-3484. refs

The functions of fracture mechanics in the residual strength and damage growth elements of the damage tolerance analysis of aircraft structures are analyzed. The characterization of fracture resistance of a material with linear elastic fracture mechanics is examined. The use of the fracture mechanics method to evaluate crack growth by the stress intensity factor is described. The development of a structural inspection maintenance program to determine the type and frequency of inspections required to detect fatigue damage is studied. An example of the damage tolerance analysis of the 757 wingbox lower surface, displaying the applicability of the technique, is presented. I.F.

A86-30498
UNDERSTANDING AND PREDICTING HELICOPTER BEHAVIOR - THEN AND NOW (LECTURE)
A. GESSOW (Maryland, University, College Park) American Helicopter Society, Journal (ISSN 0002-8711), vol. 31, Jan. 1986, p. 3-28. refs

Theories and techniques used to understand and predict helicopter characteristics are reviewed. The Glauert and Lock momentum-blade element approach, the vortex theory, free-wake method, laser Doppler techniques, and laser holographs employed to explain rotor inflow and wake are described. The application of the inflow/wake theories to the prediction of hover performance is examined. Various ground and flight techniques for evaluating forward flight performance and blade load measurements are discussed. The analyses of aeroelasticity, stability and control, and noise are studied. I.F.

A86-30550
LOGISTICS SUPPORTABILITY CONSIDERATIONS DURING CONCEPTUAL AND PRELIMINARY DESIGN
D. P. SCHRAGE and S. A. MEYER (Georgia Institute of Technology, Atlanta) Vertiflite (ISSN 0042-4455), vol. 32, Mar.-Apr. 1986, p. 48-51.

The concept formulation efforts of the 'light helicopter experimental' (LHX) program, which is based on improving combat effectiveness while reducing life cycle costs (LCCs), are described. The need to study logistic supportability considerations in the synthesis process of aircraft systems is examined. LCCs and logistic costs can be lowered by reducing: (1) the manpower required for support, (2) the cost of spares, (3) the reliance on test equipment, and (4) the cost of post development software support. Six systems for the LHX program aircraft that will lower LCCs are proposed. The economic and noneconomic benefits of the standarization of aircraft designs and the use of common components are studied. The development of a two-level maintenance system and the reduction of manpower are analyzed. The improvement of the reliability and maintainability of mission components and speed to insure self-deployability and sustainability of the aircraft is discussed. The elimination of automatic test equipment is examined. I.F.

A86-31039
THE 7J7 - BOEING'S ANSWER TO THE AIRBUS A320
M. GRANGIER Interavia (ISSN 0020-5168), vol. 41, Feb. 1986, p. 151-153.

An evaluation is made of the design features, performance, and comparative economies of the '7J7' airliner that will compete with the A320 in the 150-seat aircraft market of the 1990s. The propulsion system currently envisioned for the 7J7 uses two counterrotating unducted fans in pusher configuration. Extensive use is to be made of aluminum-lithium alloys and thermoplastic matrix composites, with a view not only to the reduction of airframe weight but of manufacturing costs. The J7J is of approximately the same dimensions as the 727-200, although cabin cross section and wingspan will both be greater. O.C.

A86-31221
COMING UP - THE 330 AND 340
A. PARTIOT Revue Aerospatiale (ISSN 0065-3780), March 1986, p. 12, 13, 15. In English and French.

The designs of the A330 and A340 are described. The A330 is a two-engined aircraft that has a 9300 km range and seats 310 passengers. A range of 12,000 km is provided by the four-engined A340. The operating cost savings possible with these aircraft due to weight reductions and new technologies are discussed. I.F.

A86-31331#
X-29 REVIVES THE EXPERIMENTAL AIRCRAFT
J. N. ALLBURN, J. P. RETELLE, JR. (DARPA, Arlington, VA), N. J. KRONE (University Research Foundation, College Park, MD), and W. E. LAMAR Aerospace America (ISSN 0740-722X), vol. 24, Feb. 1986, p. 30-33.

The canard-equipped X-29 aircraft, although built to fighter specifications, is actually a demonstrator project for innovative aerodynamic, structural and flight control concepts. The aircraft has shown that aeroelastic tailoring of advanced composites eliminates divergence of a forward swept wing, resulting in high aerodynamic and structural efficiency at high lift, increased maneuverability, agility and potential STOL. The X-29 offers control at low speed and high angle of attack, and in production aircraft would mean reduced weight and systems cost, and increased range and payload. Basic research was required before flying while accommodating maneuvering variable camber with aft flaperons, full authority canards, high pitch instability and the use of digital flight controls to stabilize an inherently unstable aircraft. The thin wing section and the control laws for stabilizing the negative static margin were major design problems that have seemed solved within the flight test envelopes thus far explored. The program has demonstrated the strength of pre-flight engineering and simulation work, while underscoring the need for flight testing to explore flight regions that cannot be well-defined without hard data to verify and improve existing models. M.S.K.

A86-31332#
UNUSUAL AERODYNAMICS OF X-29
G. SPACHT, J. CALANDRA, M. MOORE, T. TAGLARINE, J. CHIN (Grumman Corp., Aircraft Systems Div., Bethpage, NY) et al. Aerospace America (ISSN 0740-722X), vol. 24, Feb. 1986, p. 34-36, 38.

The X-29 is controlled by the pilot through the medium of a triple channel flight control system (FCS) which compensates for the 35 percent negative margin of stability of the aircraft. The aeroelasticity tailored forward-swept supercritical profile composite wings furnish lower wing profile drag during transonic maneuvering, compared to an aft-swept wings. Less drag is also present at low speeds and high angles of attack (AOA). Forward wing sweep confines separation to inboard regions to maintain attached flow at the wing tips, even at high AOA, when the full-span ailerons remain effective. Nose vortex shedding is symmetrical because of strakes which eliminate sideslip. Flow interaction between the canards and wings provides more lift for the canards at high AOA and canard downwash retards flow separation on the wings. The aerodynamic coefficients are maximized by variable camber and relaxed static stability. Three-surface trim is controlled by the multimode FCS, which can function reliably in various degraded modes, thus fulfilling a design goal of risk reduction. M.S.K.

A86-31333*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
X-29 FLIGHT - ACID TEST FOR DESIGN PREDICTIONS
T. W. PUTNAM, K. L. PETERSEN, S. D. ISHMAEL, and W. J. SEFIC (NASA, Flight Research Center, Edwards, CA) Aerospace America (ISSN 0740-722X), vol. 24, Feb. 1986, p. 40-42.

The X-29 flight test data are being disseminated to interested industrial and military users as fast as it becomes available. The aircraft is extensively instrumented with accelerometers and pressure sensors and optical sensors for measuring wing deflection. The thoroughness of preflight preparations permitted a rapid advance through initial test checkpoints, which have both confirmed many predictions and revealed several discrepancies. The flight envelope had been expanded to Mach 1.1 and an altitude of 40,000 ft by December 1985. Notably, the X-29 has provided in-flight data which could not be faithfully depicted in a simulator, e.g., flare procedures during landing, and has shown that the stability adjustments, although adequate for controlling the aircraft, are not rapid enough to offer a satisfactory margin of harmony. The tests are now being performed in the transonic regime, where supercritical airfoil and forward swept wing drag reduction become significant factors. M.S.K.

A86-31334#
X-29 AIMS AT APPLICATIONS
T. M. WEEKS (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) and T. J. WIERZBANOWSKI (USAF, Flight Test Center, Edwards AFB, CA) Aerospace America (ISSN 0740-722X), vol. 24, Feb. 1986, p. 44-46.

Once beyond high angle of attack (AOA) and transonic regime flight testing, the two X-29 research aircraft will be used to increase technology transition, expand the flight envelope of modern aircraft, for military development and testing and to incorporate and test improved or new technologies. A Committee has been established to facilitate the transfer of data from the program to government and industrial users. The ground and flight tests have furnished data on wing/canard flow interactions, structural aeroelastic effects, flutter and aeroservoelastic modes and excitation, analysis and testing techniques, flying qualities for superaugmented aircraft, and the effects of static instability. A jump strut may be tested on one of the aircraft in an attempt to shorten the necessary runway length. Also, a jet fuel-powered emergency power unit is being studied as an emergency power unit. Finally, the flight control system programming may be rewritten in ADA. M.S.K.

A86-31336#
SOVIET AIRCRAFT CLOSE TECHNOLOGY GAP
R. DEMEIS Aerospace America (ISSN 0740-722X), vol. 24, Feb. 1986, p. 56-59.

Soviet fighter design is generally ruled by the principle of evolutionary advances in proven practices and technologies. Aircraft designs are generated by indigenous talent and by concepts copied from the West. A centralized design bureau guides the efforts of separate design institutions, each normally devoted to producing a particular type of design. Cross-fertilization occurs between the different houses, e.g., delta wings onboth the MiG-21 and the Sukhoi Su-9. The aircraft are produced on a wartime basis, i.e., quantity, so ground maintenance crews are smaller to exploit the surplus of aircraft, which offsets a lack of quality or hardware sophistication. The turn-of-the-century MiG-2000 is projected to have a 500 n. mi. combat radius, a Mach 2.6 dash, GTO weight of 20 tons, and thrust/weight ratio of 1.35. Fuel consumption concerns will force the introduction of a large proportion of composite materials for structural parts. A digital avionics cockpit would have an inclined seat to permit 9 g maneuvers. The fighter would incorporate stealth technology and would carry sufficient armament for a kill on the first pass, in keeping with the historic requirements of Soviet aircraft for a high instantaneous turn rate but a deficiency in sustained turning. M.S.K.

A86-31341#
SWEDEN'S GRIPEN - A TOUGH BIRD TO TANGLE WITH
R. DEMEIS Aerospace America (ISSN 0740-722X), vol. 24, March 1986, p. 52-55.

The JAS-39 Gripen design has been selected by the Swedish government as the nation's multirole fighter into the 21st century. It will have an airframe amenable for diverse missions, a modified version of the F404J engine, and maneuvering canards. One model of the aircraft will serve ground attack, two-seat trainer, fighter/interceptor and sea-surveillance roles, with adjustments between missions handled by reprogrammable digital avionics and a distributed on-board set of microprocessor-computers. The wing span will be 26 ft, length 46 ft, and GTOW of 18,000 lb without weapons, 22,400 lb with stores. The airframe will be 30 percent carbon composites, i.e., the wing, the vertical tail, canards, intake ducts and the landing gear doors. The thrust/weight ratio of takeoff will be 1. The JAS-39 is to have STOL capabilities from 500 m of rural roads widened to 550 ft. Thrust reversal will be obviated by using the canards to lift the nose for aerodynamic braking. Ease-of-repair features are to be built into the aircraft to facilitate reliability and maintainability when the aircraft is serviced by conscripts with a short service record. The Gripen will be statically unstable and flown by means of the computers, which will furnish the pilot with three CRT screens of data plus HUD. A 28 deg inclined seat will aid the pilot in sustained high-g turns. M.S.K.

A86-31344
SU-27 - SUKHOI PLAYS ITS FLANKER
B. SWEETMAN Interavia (ISSN 0020-5168), vol. 41, March 1986, p. 275-278.

A discussion is presented concerning the design features and probable performance characteristics of the USSR's Su-27 twin-engine fighter, which is comparable to the U.S.'s F-14 and F-15 and incorporates numerous configurational features of Western fighter aircraft. Among such details are a high visibility bubble canopy, strake/wing planform, blended wing/fuselage cross section, and an I/J-band coherent Doppler radar that may be based on F/A-18 APG-65 radar design data obtained through espionage. IR search-and-track and telescopic video sensors are also incorporated underneath the engine air intakes. The most perplexing aspect of the Su-27's design is the mission which it is required to accomplish; it is presently conjectured to be a long range 'intruder' aircraft. O.C.

A86-31345
AEROSPATIALE AS.350 B1 - THE MOUNTAIN SQUIRREL
M. LAMBERT Interavia (ISSN 0020-5168), vol. 41, March 1986, p. 289-292.

A design feature and performance evaluation is presented for the recently certificated B1 version of the AS.350 high altitude/hot atmospheric conditions helicopter for mountain terrain operations. Comparisons are made between the B1 and its mountain-optimized predecessor from the same manufacturer, the Lama; the B1 is noted to possess a more fuel-efficient engine and fly faster, therefore being able to accomplish more in a given period of time than a Lama despite its 100-kg smaller payload. Dimensions and operating parameters are presented. O.C.

A86-31346
NEW INTERFACES IN THE COCKPIT
M. LAMBERT Interavia (ISSN 0020-5168), vol. 41, March 1986, p. 295-297.

General aviation, military aircraft, helicopter and airliner flight decks are being transformed by three dynamically developing technologies: digital avionics, side stick controllers, and pilot voice control procedures. Attention is given to the 'Starship' executive tubes possessing their own symbol generators. Side stick controllers are considered ideal pilot interfaces with a fly-by-wire system such as that of the A320 airliner, clearing the pilot's line-of-sight to the windscreen and flight deck. Special usefulness is noted in the application of voice control technology to helicopters engaged in nap-of-the-earth operations. O.C.

A86-31413
A STUDY OF THE EFFECT OF CERTAIN FACTORS ON THE FATIGUE STRENGTH OF STRUCTURAL IRREGULARITIES IN THE AIRFRAME OF AIRCRAFT [ISSLEDOVANIE VLIIANIIA NEKOTORYKH FAKTOROV NA DOLGOVECHNOST' KONSTRUKTIVNYKH NEREGULIARNOSTEI PLANERA SAMOLETA]
N. V. KOSHELEV Samoletostroenie - Tekhnika Vozdushnogo Flota (ISSN 0581-4634), no. 51, 1984, p. 35-39. In Russian. refs

Problems associated with ensuring the fatigue strength of the airframe of an aircraft in irregular zones at the stage of design are examined. In particular, attention is given to factors determining the fatigue strength of typical joints, such as those securing the tip of a stiffness element to the skin and butt joints between skin panels, in relation to the design parameters. Practical recommendations concerning the selection of the joint size are given. V.L.

A86-31657#
PERIODIC CONTROL FOR MINIMUM-FUEL AIRCRAFT TRAJECTORIES
W. GRIMM, K. H. WELL (DFVLR, Institut fuer Dynamik der Flugsysteme, Wessling, West Germany), and H. J. OBERLE (Hamburg, Universitaet, West Germany) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, Mar.-Apr. 1986, p. 169-174. refs

The problem of minimizing fuel consumption of an aircraft is formulated as an optimal control problem with periodic boundary conditions. Two problems are considered: one with constant aircraft weight and one with variable weight. Numerical solutions are computed via a multiple-shooting method and consist of bang-bang control actions for power setting. In comparison to the steady-state solutions, savings in fuel consumption for an F-4-type aircraft are approximately 2 percent. The solution obtained is shown to satisfy the second-order sufficiency conditions for a weak local optimum. Author

A86-31849
COCKPITS FOR 2010 AND BEYOND
P. I. SUMMERS (McDonnell Aircraft Co., St. Louis, MO) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 1, Feb. 1986, p. 17-20.

A proposed cockpit design for fighter aircraft is described. The ground-based mission planning system is discussed. The use of a

forebody concept to accommodate the physiological needs of the crew is examined. An armrest control module is proposed for controlling attitude and thrust. The encapsulation of the crew station and display systems such as the helmet mounted sight and display system are studied. The application of artificial intelligence and biocybernetics to the cockpit of the aircraft is analyzed. I.F.

A86-32067
COMPARISON OF F-101 EJECTION SEAT AND ACES II STATIC AERODYNAMIC COEFFICIENTS
L. J. SPECKER (USAF, Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) SAFE Journal, vol. 16, Spring 1986, p. 6-13. refs

High-speed ejection trajectories and accelerations remain unpredictable and low-speed ejections can be predicted only if the simulation program has been updated to reflect changes in ejection seat design and aerodynamic influencing factors. This paper describes the computer simulation model, the aerodynamic adjustments necessary to achieve correlation with test data, and the results obtained after a comparison was made between F-101 ejection seat and Advanced Concept Ejection Seat (ACES) II test data. It was found that the static aerodynamic coefficients of the F-101 were not similar to those of the ACES II when the seat reference point is used as the moment reference center. Moreover, each of the six static aerodynamic coefficients of the F-101 are significantly different from those of ACES II when measured in low-speed wind tunnel tests. It is concluded that static aerodynamic coefficients collected using the F-101 ejection seat cannot be used to calculate the performance of an ACES II when aerodynamic forces are predominant in the ejection sequence. K.K.

A86-32074#
NEW RESEARCH AIRCRAFT FOR DFVLR
Dornier-Post (English Edition) (ISSN 0012-5563), no. 3, 1985, p. 15-17.

Features relating to the structure and performance of the Dornier 228 aircraft are described and a summary of future flight projects is given. The rectangular cabin (6.30 m long, 1.35 m wide, 1.55 m high) permits the simultaneous housing of different control, evaluation and recording devices as well as scientific pesonnel. Complex sensors which may be installed include MSS, SAR, SLAR, and SCAT. When flying at 1000 ft, the aircraft's noise level of 74.1 dB(A) is 5.9 dB(A) below the admissible limit, allowing for research missions over residential areas. Dornier 228 offers excellent low-speed flying characteristics around 100 km/hr as well as a high cruise speed with a maximum of 430 km/hr; and the use of a mobile oxygen system allows flight measurements up to an altitude of 25,000 ft. Because of this performance spectrum, the Dornier 228 is capable of such projects as the thermal mapping of temperature distribution in city regions and the monitoring of the ocean, forests, and the atmosphere. K.K.

A86-32075#
THE IA 63 TRAINER
B. STRAETER and K. H. MOHR Dornier-Post (English Edition) (ISSN 0012-5563), no. 3, 1985, p. 29-31.

After three years of preparatory work, a first agreement on cooperation was signed in 1979 by the Argentine Air Force and Dornier GmbH for the development of the IA 63 basic/advanced jet trainer. The IA 63 is a single-engined jet trainer with a shoulder-mounted nonswept trapezoidal wing with a supercritical section. This wing, characteristic of the IA 63, was designed for a high maximum lift during takeoff and landing and fo low drag and high lift during cruise and in maneuvers. The tricycle landing gear with single wheels is suitable for landings on unpaved airstrips, and the seat position coupled with a one-piece cockpit canopy opening to the rear offers excellent visibility. The success of IA 63 prototypes in October 1984 and in August 1985 attests to its reliability in training missions, simplicity is maintenance, and inherent level of technological expertise. K.K.

A86-32076*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
X-29A ADVANCED TECHNOLOGY DEMONSTRATOR PROGRAM OVERVIEW
W. J. SEFIC (NASA, Flight Research Center, Edwards, CA) and W. CUTLER (Grumman Corp., Grumman Aircraft Systems Div., Bethpage, NY) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 16 p.
(AIAA PAPER 86-9727)

The present discussion of the X-29A forward-swept wing experimental aircraft's functional flight program and concept evaluation program gives attention to the program management structure for a test team that encompasses NASA, the U.S. Air Force, and the prime contractor for the X-29A. The preflight, flight-functional, envelope-expansion and flight research test objectives of the program are also noted, together with the qualitative characterizations obtained to date for both a limited envelope flight control system and one for an expanded envelope. O.C.

A86-32077*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FLIGHT TEST OF A DECOUPLER PYLON FOR WING/STORE FLUTTER SUPPRESSION
F. W. CAZIER, JR. (NASA, Langley Rearch Center, Hampton, VA) and M. W. KEHOE (NASA, Flight Research Center, Edwards, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 13 p. refs
(AIAA PAPER 86-9730)

The decoupler pylon is a NASA concept of passive wing-store flutter suppression achieved by providing a low store-pylon pitch frequency. Flight tests where performed on an F-16 airplane carrying on each wing an AIM-9J wingtip missile, a GBU-8 bomb near midspan, and an external fuel tank. Baseline flights with the GBU-8 mounted on a standard pylon established that this configuration is characterized by an antisymmetric limited amplitude flutter oscillation within the operational envelope. The airplane was then flown with the GBU-8 mounted on the decoupler pylon. The decoupler pylon successfully suppressed wing-store flutter thoughout the flight envelope. A 37-percent increase in flutter velocity over the standard pylon was demonstrated. Maneuvers with load factors to 4g were performed. Although the static store displacements during maneuvers were not sufficiently large to be of concern, a store pitch alignment system was tested and performed successfully. One GBU-8 was ejected demonstrating that weapon separation from the decoupler pylon is normal. Experience with the present decoupler pylon design indicated that friction in the pivoting mechanism could affect its proper functioning as a flutter suppressor. Author

A86-32082#
MODELING OF AIRCRAFT CRUISE PERFORMANCE USING ACCELERATION AND DECELERATION MANEUVERS - RESULTS AND APPLICATION
T. R. YECHOUT (U.S. Air Force Academy, Colorado Springs, CO) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 11 p.
(AIAA PAPER 86-9735)

A flight test technique has been developed under NASA Dryden sponsorship to predict aircraft cruise performance characteristics. The technique used acceleration and deceleration maneuvers to define baseline aerodynamic and propulsion system characteristics which were then input to a performance modeling prediction program. Conventional stabilized 'speed power' tests, which are normally used for cruise performance definition, can comprise a large portion of the flight time in a program. A significant reduction in flight time was estimated using the performance modeling approach, with associated savings in cost and schedule. A 20-hour verification flight test program was accomplished using a Learjet Model 35 aircraft. Author

A86-32083#
X-29A FLIGHT FLUTTER DATA ANALYSIS BY ADVANCED METHODS
M. L. RUSSO (Grumman Corp., Data Systems Div., Holtsville), M. P. HEALY, and M. P. BROCK (Grumman Corp., Aircraft Systems Div., Calverton, NY) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 11 p. refs
(AIAA PAPER 86-9737)

Because of the X-29 forward-swept wing experimental aircraft's novel structural dynamics, flight flutter testing is initially conducted without a shaker system; it is therefore necessary to estimate aircraft flutter parameters on the exclusive basis of random excited data. The approach presented uses a maximum likelihood parameter identification technique. A computer code, 'TASKX', employs an initial model together with flight data to make maximum likelihood estimates of the true aeroelastic model from which flutter parameters are extracted. Favorable results are obtained using TASKX to analyze fin, wing, and fuselage response measurements from the X-29. O.C.

A86-32096#
FLIGHT TEST TECHNIQUES USED FOR CARRIAGE LOAD MEASUREMENTS AT LARGE UNDERFUSELAGE STORE CONFIGURATIONS ON TORNADO COMBAT A/C
F. J. RUDOLPH (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 11 p.
(AIAA PAPER 86-9755)

Flight tests have been carried out in order to measure the carriage loads associated with the Multi-Weapon Carriage System (MWCS) of the Tornado combat aircraft. In particular, carriage loads have been collected from large underfuselage stores in a container configuration (MW1), a quadruple store carriage system (QSC), and an aerial target system (DATS). Detailed descriptions of the loads instrumentation, calibrations, software preparations and tests techniques, are given, and the load measurement data are presented in graphic form. A line drawing illustrating the trajectory of the container system at the moment of jettison is provided. I.H.

A86-32097*# PRC Kentron, Inc., Hampton, Va.
NATURAL LAMINAR FLOW FLIGHT EXPERIMENTS ON A TURBINE ENGINE NACELLE FAIRING
C. J. OBARA (PRC Kentron, Inc., Hampton, VA), E. C. HASTINGS, J. A. SCHOENSTER, T. L. PARROTT, and B. J. HOLMES (NASA, Langley Research Center, Hampton, VA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 11 p. refs
(AIAA PAPER 86-9756)

Flight experiments are being conducted with the objective to investigate the interactions between acoustic disturbances and laminar flow in the flight environment. In the experiments, the laminar boundary layer on the nacelles will be exposed to discrete and broadband external noises, and the effect of varying noise levels and frequencies on the stability of the laminar flow will be studied. The present paper provides an overview of the complete project and a status report on the results which have been obtained. The flight experiment is conducted with the aid of a modified research aircraft. The phase I flight tests are concerned with a quick and simple determination of natural laminar flow (NLF) behavior on an engine nacelle. Attention is given to instrumentation, the acoustic noise source, flow visualization, and the test results. G.R.

A86-32098#
SINGLE HEADING CLIMBS - AN ALTERNATE TECHNIQUE FOR DETERMINING PERFORMANCE
A. J. DEPASQUALE and I. J. BAILLIE (Douglas Aircraft Co., Long Beach, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 5 p.
(AIAA PAPER 86-9757)

This paper presents an alternate flight technique for determining actual climb performance levels on jet transport category airplanes. The current technique requires demonstration of reciprocal heading crosswind climbs. The new technique requires only single heading climbs using an INS installation and adhering strictly to onboard stability monitoring criteria. This concept has been validated by reanalysis of previous test results from reciprocal heading crosswind climb demonstrations, and by use of stringent onboard stability monitoring criteria during the MD-83 program. FAA Draft Advisory Circular AC No. 25-XX accepts this concept as valid. It will reduce the current flight hours required to demonstrate actual climb performance levels by 50 percent, shorten test schedule time, and reduce the total man-hours spent in data analysis. Author

A86-32101#
DEVELOPMENT AND FLIGHT TESTING OF THE T-2 CONTROL CONFIGURED VEHICLE
M. YASUE, A. TAKEKOSHI, H. KANNO, M. NAKAO, K. SHIBATA (Japan Defense Agency, Technical Research and Development Institute, Tokyo) et al. AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 10 p.
(AIAA PAPER 86-9763)

The design, development, and testing of the T-2 control configured vehicle (CCV) are described. Th installation of a triplex digital fly-by-wire (FBW) flight control system into the T-2 is analyzed. The components of the FBW control system and the modes of the CCV are examined. The flight testing of the T-2 CCV is studied; the four phases of the testing include: (1) system checkout/envelope expansion/preliminary evaluation, (2) handling qualities evaluation, (3) CCV mode evaluation, and (4) operational evaluation. The test data reveal that the flight control system reliability and handling qualities are satisfactory. The application of the CCV concept and FBW system to modern high performance aircraft is discussed. I.F.

A86-32102#
INTEGRATING THE PILOT INTO THE COCKPIT
M. B. JOHNSTON and A. V. WOLFE (General Dynamics Corp., Fort Worth, TX) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p.
(AIAA PAPER 86-9765)

The designing of cockpits to fulfill mission requirements is studied. The need for pilot-vehicle interface (PVI) is discussed. The objectives of the PVI Project Lead are examined. The use of simulation in cockpit design is described. Examples displaying the progression of cockpit design complexity and workloads are presented. I.F.

A86-32103#
T-46A FLIGHT TEST RESULTS
W. H. SHAWLER (Fairchild Republic Co., Edwards, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 5 p.
(AIAA PAPER 86-9766)

The handling qualities, one G and accelerated stalls, takeoff and landing characteristics, engine operation, and subsystems of the T-46 aircraft are analyzed. The configuration and capabilities of the T-46 aircraft are described; engine and flight control system designs are exmined. The test data reveal that improvements in the lateral and longitudinal trims, stall warning, and speed brake panels are required. The T-46 performance was compared to the 62 percent model aircraft, which is a composite aircraft weighing

842 pounds; good correlation of performance data is observed. I.F.

A86-32107*# San Jose State Univ., Calif.
FLIGHT TEST PLANNING AND PARAMETER EXTRACTION FOR ROTORCRAFT SYSTEM IDENTIFICATION
J. C. WANG, M. Y. DEMIROZ (San Jose State University, CA), and P. D. TALBOT (NASA, Ames Research Center, Moffett Field, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 16 p. refs
(Contract NCC2-297)
(AIAA PAPER 86-9772)

The present study is concerned with the mathematical modelling of aircraft dynamics on the basis of an investigation conducted with the aid of the Rotor System Research Aircraft (RSRA). The particular characteristics of RSRA make it possible to investigate aircraft properties which cannot be readily studied elsewhere, for example in the wind tunnel. The considered experiment had mainly the objective to develop an improved understanding of the physics of rotor flapping dynamics and rotor loads in maneuvers. The employed approach is based on a utilization of parameter identification methodology (PID) with application to helicopters. A better understanding of the contribution of the main rotor to the overall aircraft forces and moments is also to be obtained. Attention is given to the mathematical model of a rotorcraft system, an integrated identification method, flight data processing, and the identification of RSRA mathematical models. G.R.

A86-32108#
FLIGHT TEST SIMULATION OF THE T-46
J. C. PICK (USAF, Edwards AFB, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p.
(AIAA PAPER 86-9773)

This paper describes the development and structure of the T-46A flight test simulation at the U.S. Air Force Flight Test Center, and emphasizes two interesting aspects of the simulation: (1) an electrohydraulic force-feel system is driven by a digital computer to model a reversible flight control system; and (2) data for extremely high angles-of-attack are incorporated into the simulation in order to simulate aircraft stall, departure, spin, and recovery. The use of this simulation as a tool to make performance and flying qualities testing safer, more effective, and more efficient is also discussed. Author

A86-32109#
F-14A LOW ALTITUDE HIGH ANGLE OF ATTACK SIMULATION AND FLIGHT TEST PROGRAM
R. J. GOODMAN and P. E. CONIGLIARO (Grumman Corp., Aircraft Systems Div., Calverton, NY) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 11 p.
(AIAA PAPER 86-9774)

The loss of several F-14A aircraft in apparent spin-related accidents during 1976-79 has led to the initiation of a series of flight test programs to investigate the high angle of attack departure characteristics of this twin engine, variable-sweep fighter. A review is presented regarding the technical considerations in applying ground-based piloted simulation to support F-14A high angle of attack flight testing in general, and the Low Altitude Asymmetric Thrust Test Program, in particular. It is found that piloted simulation support is a necessary means of enhancing flight test safety, productivity, and data analysis. Attention is given to simulation model updates, simulation fidelity issues, simulation-flight test philosophy, simulation test planning and on-site support, simulation verification flight testing, and critical store configuration testing. G.R.

A86-32112#
HOW TO MAKE SIMULATORS FLY LIKE AIRPLANES
L. G. JANSSENS and T. MARSHALL (USAF, Wright-Patterson AFB, OH) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 9 p.
(AIAA PAPER 86-9777)

A new technique for generating simulation data packages from flight testing data is described. The use of a digital flight test data system, an intgrated math model, and a six-degree-of-freedom engineering simulation model is examined. The performance, propulsion, handling qualities, and stability and control characteristics of the test aircraft were measured, and the data was evaluated with the simulation data system. The procedure for measuring angle of attack and sideslip is discussed. Good correlation between flight test data and computer model simulation data is observed. I.F.

A86-32113#
INVESTIGATION OF MAIN LANDING GEAR TIRE TEMPERATURES DURING TAXY-OUT AT HEAVY TAKE-OFF MASSES
H. KERNER (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p.
(AIAA PAPER 86-9778)

Main gear tire temperature behavior in the Tornado aircraft is evaluated. The procedures for measuring the tire bead temperature of 30 x 11.50 and 30 x 14.5 tires with 24 and 26 ply ratings are described. The effects of ambient temperature, taxi-speed, and brake activity are studied. The testing of the tires at 6 and 33 C reveals that the tire bead temperature is dependent on radiation and a linear relationship between tire temperature and ambient temperature is observed. Brake activity and taxi-speed data are compared to towing data; a higher tire bead temperature caused by taxi-speed is detected in the taxiing aircraft. The cooling behavior of the tires is analyzed. The data reveal that the 24 ply rating tire is applicable for aircraft with low masses and shorter turn-around times, and the 26 ply rating tire displays good performance due to improved stiffness and higher mass. I.F.

A86-32115#
X-29 GROUND AND FLIGHT SUBSYSTEM TESTING
E. TOBIASON and R. MCSHEA (Grumman Corp., Edwards, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 7 p.
(AIAA PAPER 86-9781)

The concept of a manned research aircraft dedicated to the single purpose of testing high-risk aerospace technology was revitalized with the X-29 Advanced Technology Demonstrator. The first flight with the X-29 was conducted on December 14, 1984. The flight test environment is considered along with the X-29 subsystem design, a subsystem description, test plans aspects of program development, Calverton ground test results, and initial flight testing. It is pointed out that as a result of the 32 flights flown to date, many of the original flight test objectives have been attained. Thus, the advanced technologies incorporated in the X-29 design have proven feasible in actual flight. G.R.

A86-32116#
INFLIGHT EXCITATION OF THE F-16XL
S. C. TIERNEY (USAF, Flight Test Center, Edwards AFB, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 6 p.
(AIAA PAPER 86-9782)

During flight testing of the General Dynamics F-16XL fighter aircraft, a 2.5 Hertz oscillation in the aircraft longitudinal axis was encountered in the 0.90-0.95 Mach range at all altitudes. This oscillation was not predicted on the contractor simulator, which utilized flight test derived aerodynamics and a model of the flight control computer. Flight testing identified the amplitude of the oscillation to be system gain-dependent in the longitudinal axis.

The inflight excitation test procedure was developed to obtain the aircraft frequency response inflight, utilizing the actual hardware and aerodynamics at any condition within the flight envelope. Inflight excitation test results indicated a high gain system in the longitudinal axis, with -180 degrees of phase angle in the frequency range where the longitudinal oscillation existed. A gain nonlinearity in the aircraft actuators was identified as a major contributor to the limit cycle oscillation. The test procedure discussed has potential application to future aircraft with augmented flight controls by reducing flying qualities test time and increasing the level of safety involved in opening an aircraft flight envelope. Author

A86-32118*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
IN-FLIGHT FLOW VISUALIZATION OF F-106B LEADING-EDGE VORTEX USING THE VAPOR-SCREEN TECHNIQUE
J. E. LAMAR, R. A. BRUCE, J. D. PRIDE, JR., R. H. SMITH, P. W. BROWN (NASA, Langley Research Center, Hampton, VA) et al. AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 10 p. refs
(AIAA PAPER 86-9785)

A flight program was conducted with the objective to study the vortex flow systems existing around the F-106B aircraft. Level 1-G decelerating flight with varying angle of attack was considered along with conditions involving G levels in the range from 4.5 to 5.5 and angles of attack in the range from 16 to 19 degrees. It was demonstrated that the vapor screen technique can be applied successfully to flight vehicles under a variety of test conditions, taking into consideration the transonic maneuver performed by fighter aircraft. Details regarding the employed in-flight flow visualization technique are discussed, taking into account the seeding system, the light sheet system, the video system, the control system, and the recording of the data. Attention is also given to the flight program, the data development, and the scientific observations. G.R.

A86-32119#
CONSTANT ALTITUDE HELICOPTER FLIGHT TESTING
D. M. LAYTON (Per Safe, Salinas, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 6 p.
(AIAA PAPER 86-9787)

Helicopter performance is evaluated using conventional and constant altitude testing. The equations for induced, profile, parasite, and tail rotor powers, which are needed to sustain a single main rotor helicopter in level, unaccelerated forward flight, are presented; in order to maintain a constant coefficient of power a constant weight/density ratio is required. The relations between fuel consumption, pressure, altitude, temperature, and density ratio values are analyzed. The procedures for the constant altitude technique are described. Light and heavy weight helicopters performance was measured at a constant altitude; accurate density ratio values that correlate well with conventional testing data were obtained. I.F.

A86-32132#
HIGH TECHNOLOGY TEST BED PROGRAM
C. B. PAYNE (Lockheed-Georgia Co., Marietta) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 10 p.
(AIAA PAPER 86-9803)

The High Technology Test Bed (HTTB) program, initiated in 1984, is concerned with the addition of performance-enhancing design features to a Hercules test aircraft which facilitate Short Takeoff and Landing (STOL) capabilities and generally enhance tactical cargo mission survivability. Advanced electronics, avionics and cockpit designs are incorporated. Attention is given to the 'tactical assault mission' threat scenario which furnishes the context for HTTB design requirements. The new cockpit incorporates a cockpit management system, a HUD, programmable displays, and an autothrottle. A 'Special Avionics Mission Strap-On Now' pod is used to enhance mission adaptability. O.C.

A86-32133#
EXPERIENCE WITH FLIGHT TESTING INTEGRATED AVIONICS SYSTEMS
F. E. PARLINI and J. R. COMBLEY (Boeing Commercial Airplane Co., Seattle, WA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 6 p.
(AIAA PAPER 86-9804)

The development and testing of the Boeing aircraft integrated digital Flight Management System (FMS) is discussed. On the 747, the INS was followed by the engine thrust limit computer, which led to the Performance Management System, which was then interfaced with the INS, autopilot and autothrottle to provide lateral/vertical navigation FMS capability. Digital avionics follow ARINC 700 and 429 specifications, and include the use of a Mark 33 Digital Information Transfer System. Integrated system testing involves both laboratory testing, including the employment of an engineering flight simulator, and inflight testing, including the use of the PADDS data recording system for troubleshooting on customer aircraft. A flight test bus has also proved useful in providing outputs of internal signals, and a navigation performance program has been developed for data analysis purposes. R.R.

A86-32134#
TORNADO AVIONIC FLIGHT TESTING
E. PEARSON (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 7 p.
(AIAA PAPER 86-9805)

The avionic flight testing of the IDS (interdiction and strike) Tornado, a variable wing, fly-by-wire, multiweapon aircraft capable of treetop penetration in all weather conditions, is described. Following avionic subsystem development, and testing aboard two Buccaneer aircraft, Tornado prototypes were flight tested in England, Germany and Italy. The test reference system for the navigation tests employed a combination of an external surveillance radar and vertical photography with aircraft attitude compensation. Weapon aiming testing used release point assessments, and ballistic constants were measured by kinetheodolite tracking. The terrain following/autopilot-flight director testing objective of 200-ft set clearance height/0.9 Mach flight, was achieved in instrument meteorological conditions in 1985. R.R.

A86-32137#
SPECIFIC EXCESS POWER APPLICATIONS FOR ROTARY WING AIRCRAFT
C. A. PARLIER (McDonnell Douglas Helicopter Co., Mesa, AZ) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 7 p. refs
(AIAA PAPER 86-9810)

Traditional rotary wing flight test techniques emphasize basically static performance parameters. As a result, there is a void in the empirical data obtained for helicopters. The lack of dynamic performance data has been highlighted by efforts to increase the fidelity of flight simulation models and smart flight control systems, as well as the pilot's understanding of the maneuvering capability of the aircraft. Specific excess power (Ps) test techniques can be used to partially fill-in the data voids which presently exist.
Author

A86-32138*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
CLOUD PARTICLE EFFECTS ON LAMINAR FLOW IN THE NASA LEFT PROGRAM - PRELIMINARY RESULTS
R. E. DAVIS, M. C. FISCHER (NASA, Langley Research Center, Hampton, VA), D. F. FISHER, and R. YOUNG (NASA, Flight Research Center, Edwards, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 11 p. refs
(AIAA PAPER 86-9811)

Laminar flow offers the promise of significant fuel savings on future commercial transport aircraft, but laminar flow can be lost while encountering clouds or haze at cruise conditions. To quantify the effect of cloud particles on laminar flow during typical airline operating conditions, and evaluate candidate cloud particle detection instrument concepts for future laminar flow aircraft, two types of cloud particle detectors are being flown aboard a NASA JetStar aircraft in the Leading Edge Flight Test (LEFT) program. The instrumentation is described, and preliminary results and conclusions are presented. Author

A86-32143#
BIRD IMPACT TESTING AT AEDC'S RANGE S-3
V. CENTONZE and N. M. SCHMOEKER (USAF, Arnold Engineering Development Center, Arnold Air Force Station, TN) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p.
(AIAA PAPER 86-9818)

The considered facilities for bird impact testing consist of three parts, including the driver, the launch tube, and the concrete test pad. The driver has the objective to accelerate the bird to the desired launch velocity. It contains a 31-ft-long chamber with an 8-in.-diameter bore, and a volume of 10.8 cu ft. The launch tube is a 120-ft-long tube comprised of two rigidly mounted sections. A covered concrete test pad, where the target and its associated instrumentation are housed, constitutes the outdoor portion of the range. The test operations are discussed, taking into account the projectile, sabots, sabot strippers, test instrumentation, velocity measurement, deflection measurements, and strain, acceleration, pressure, and temperature measurements. Attention is also given to planned facility improvements, test projects, and aircraft component testing. G.R.

A86-32147#
A NEW RAIN/ICE TEST CAPABILITY TO SIMULATE FLIGHT
G. R. BEITEL and R. K. MATTHEWS (Calspan Corp., Arnold Air Force Station, TN) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p. refs
(AIAA PAPER 86-9824)

A supersonic rain simulation environment to test the impact of rain and ice on aircraft and missile airframes has been developed. The ice particles are suspended in a liquid nitrogen carrier and injected into the tunnel upstream of the nozzle. During laboratory tests of the injection system, 500-micron ice particles were discharged at rates up to 500,000 particles per sec for durations up to 60 seconds. The characteristics of a particulate cloud prior to impact with the test article were determined using a laser diagnostics system; particle velocities were measured using a laser Doppler velocimeter. A detailed description of the calibration test program for the simulator is given. I.H.

A86-32776#
A REVIEW OF COMPUTER SIMULATIONS FOR AIRCRAFT-SURFACE DYNAMICS
G. R. DOLE, JR. (Dayton, University, OH) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 257-265. USAF-sponsored research. refs

Techniques for the dynamic simulation of aircraft-surface operations are examined. The computer programs are designed to predict gear loads, structural response, and soil behavior for aircraft traversing bomb damage repaired runways or manuevering on soil. The capabilities and limitations of the programs are described. The range of simulation codes from linear, single-degree-of-freedom models to nonlinear three-dimensional models with flexible airframe modes is studied. The validation of the codes is discussed. The use of time-domain analysis to predict catastrophic failure is investigated. I.F.

A86-32787*# PRC Kentron, Inc., Hampton, Va.
NEW AND EXISTING TECHNIQUES FOR DYNAMIC LOADS ANALYSES OF FLEXIBLE AIRPLANES
A. S. POTOTZKY (PRC-Kentron, Inc., Aerospace Technologies Div., Hampton, VA) and B. PERRY, III (NASA, Langley Research Center, Hampton, VA) (Structures, Structural Dynamics, and Materials Conference, 26th, Orlando, FL, April 15-17, 1985, Technical Papers. Part 2, p. 651-663) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 340-347. Previously cited in issue 13, p. 1849, Accession no. A85-30394. refs

A86-33237
A NUMERICAL ANALYSIS FOR VERTICAL GUST FIELD INDUCED BY GUST GENERATOR
Y. YANG and J. WANG (Northwestern Polytechnical University, Xian, People's Republic of China) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 187-193.

This paper presents a calculating method for vertical gust field induced by gust generator which consists of a group of oscillating vanes based on subsonic unsteady lifting surface theory. When the geometry of the gust generator, oscillating frequency and amplitude, Mach number are given, the unsteady downwash field can be determined. In the calculation, the interference among the vanes are considered. Through numerical calculation, the characteristics of the vertical gust field induce by one, two, or three vanes with various reduced frequencies and Mach numbers are investigated. The influence of the gust generator on the characteristics of the vertical gust field are discussed, and some profitable conclusions for gust wind tunnel design are also obtained. Author

A86-33239
EXPERIMENTAL TRANSONIC PRESSURE DISTRIBUTIONS OF A FLEXIBLE WING-AILERON MODEL AND COMPARISONS WITH RESULTS OF SEVERAL THEORETICAL METHODS
D. GUAN, W. LIU, Z. GAO, and Y. ZHANG (Shenyang Aircraft Corp., People's Republic of China) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 211-218.

Analytical methods for the prediction of transonic load distribution due to large aileron deflection angle on a flexible wing were investigated. A 60-deg delta wing model with representative stiffness level and deflected aileron was tested in a high speed wind tunnel and pressure distributions were measured. Second-order transonic small disturbance theory, linearized aerodynamic theory and an empirical method based on rigid model pressure distributions were used to calculate the load distribution. It seems that the empirical method is more powerful. Author

A86-33241
STATIC AEROELASTIC ANALYSIS USING AIRCRAFT VIBRATION MODES
Z. SHEENA and M. KARPEL (Israel Aircraft Industries, Ltd., Lod) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 229-232.

A method for the calculation of the airload distribution and aeroelastic effectiveness parameters of a flexible aircraft from the distribution of a rigid one, using its vibration modes, is presented here. The traditional methods of solving problems involving static aeroelasticity use the discrete model of an aircraft. Such a model usually has hundreds of degrees of freedom. The method presented here uses modal data of the model in the form of a limited number

of low frequency mode shapes and their associated generalized stiffnesses. The mathematical operations in this case are done on the generalized matrices of the model which have a small number of degrees of freedom. The uniqueness of this method is in its capability to calculate the static aeroelastic properties of a free-free aircraft using its elastic, inertial and aerodynamic properties. Another advantage of this method is that it is suitable for making parametric analyses involving changes in the stiffness of the structure and the aerodynamics of the model. Numerical examples are given and the convergence with the number of modes taken into account is discussed. Author

A86-33242
A REVIEW OF AEROELASTIC RESEARCH AT THE FLIGHT DYNAMICS LABORATORY
T. M. HARRIS, T. E. NOLL, T. J. HERTZ, and W. A. SOTOMAYER (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: International Symposium on Aeroelasticity and structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 233-243. refs

Development history and current development status evaluations are conducted for the primary research areas in the field of aeroelasticity that have been investigated by the Flight Dynamics Laboratory of the U.S. Air Force's Wright Aeronautical Laboratories. There areas are: (1) aeroservoelasticity, developing tools for the aeroelastic analysis of aircraft when active feedback control systems are taken into account; (2) adaptive flutter suppression, for aircraft carrying external stores; (3) the effect of external stores carriage on body freedom flutter for forward swept wings; and (4) three-dimensional transonic unsteady aerodynamic codes. O.C.

A86-33243* National Aeronautics and Space Administration, Washington, D.C.
SELECTED TOPICS IN EXPERIMENTAL AEROELASTICITY AT THE NASA LANGLEY RESEARCH CENTER
R. H. RICKETTS (NASA, Material and Structures Div., Washington, DC) IN: International Symposium on Aeroelasticity and structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 244-256. Previously announced in STAR as N85-30364. refs

The results of selected studies that have been conducted by the NASA Langley Research Center in the last three years are presented. The topics presented focus primarily on the ever-important transonic flight regime and include the following: body-freedom flutter of a forward-swept-wing configuration with and without relaxed static stability; instabilities associated with a new tilt-rotor vehicle; effects of winglets, supercritical airfoils, and spanwise curvature on wing flutter; wind-tunnel investigation of a flutter-like oscillation on a high-aspect-ratio flight research wing; results of wing-tunnel demonstration of the NASA decoupler pylon concept for passive suppression of wing/store flutter; and, new flutter testing methods which include testing at cryogenic temperatures for full scale Reynolds number simulation, subcritical response techniques for predicting onset of flutter, and a two-degree-of-freedom mount system for testing side-wall-mounted models. Author

A86-33244
AEROELASTIC WIND TUNNEL SIMILARITY THEORY FOR ANISOTROPIC AIRCRAFT WINGS
G. A. OYIBO (Fairchild Republic Co., Farmingdale, NY) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 257-264. refs

An examination of the fundamental aeroelastic equations of motion for anisotropic aircraft wings, with the help of affine transformations, indicates that a unified aeroelastic simulation theory can be formulated which reduces to the current theory in the isotropic limit. The necessary condition for preserving the Strouhal number between the real aircraft wing and its wind tunnel model is found to lie in the preservation of the generalized forms of the similarity parameters suggested by Theodorsen and Garrick (1940), as well as new parameters reflecting the various directional and coupling stiffness properties of anisotropic materials in a given aerospace structure. The use of these analysis results should significantly improve the understanding of previous wind tunnel data on anisotropic aircraft wings. O.C.

A86-33245
THE CHOICE OF TECHNIQUES USED FOR FLIGHT FLUTTER CLEARANCE WITH PARTICULAR REFERENCE TO THE BAE 146 AND BAE 125
A. G. WOODS (British Aerospace, PLC, Civil Div., Hatfield, England) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 265-275. refs

Decisions must be made during the design of an aircraft regarding the most appropriate flight test method to be used to obtain flight flutter clearance. These decisions must be made in sufficient time to allow for the design and manufacture of test equipment, also for writing and testing the associated analysis programs. This paper discusses the background to the choice of techniques to be used, with special reference to the recently completed flight flutter tests of the BAe 146 feeder liner and the BAe 125 Series 800 executive jet. Details of the chosen methods of excitation, recording and analysis are given for these aircraft, with typical results. Author

A86-33247
EXPERIENCE WITH AEROELASTIC ANALYSIS OF A SINGLE ENGINE TURBO TRAINER USING FINITE ELEMENTS METHODS
M. J. REINICKE, A. S. TURI (Pilatus Aircraft, Ltd., Stans, Switzerland), and A. VOLLAN (Omega GmbH, Immenstaad, West Germany) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 286-296.

PILATUS' experience with the aeroelastic analysis of a single engine Advanced Turbo Trainer is presented. Thence a aconcept is worked out for current and future applications. The present aeroelastic analysis is based on theoretical approach using finite element methods. Dynamic analysis results are validated by comparison with those from ground vibration tests of a similar structure. MSC/NASTRAN solutions were used for both dynamic and aeroelastic analysis. Rigid Formats were extensively altered to achieve higher flexibility. CPU time requirements were drastically reduced by the use of a NASTRAN DMAP program allowing parametric variation of modal mass, stiffness and damping. Calculated flutter results are compared with those from flight test. Author

A86-33256
THE APPLICATION OF PRACTICAL OPTIMIZATION TECHNIQUES IN THE PRELIMINARY STRUCTURAL DESIGN OF A FORWARD-SWEPT WING
E. LERNER (Grumman Aerospace Corp., Bethpage, NY) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 381-392. refs

In the mid-seventies, a renewed interest in forward-swept wings stemmed from the emergence of advanced composite materials for use in lifting-surface design. At about that same time, investigators in the field of structural optimization were suggesting automated procedures for achieving least-weight designs of surfaces subjected to aeroelastic as well as strength requirements. This paper describes the application of optimization technology in preliminary design studies that preceded the full development of the Grumman X-29, forward-swept-wing, demonstrator aircraft. A review is given of finite-element resizing methods that were

developed to satisfy optimality criteria for strength and divergence-velocity constraints. Application of the methods in an initial feasibility study of a variable-sweep wing and, later, in a more-detailed, fixed-wing design study are described. The usefulness of the methodology at various stages of design is demonstrated by tracing the process that led to the selection of an efficient cover-laminate configuration. Author

A86-33257
STRUCTURAL OPTIMISATION PROGRAMS AND METHODS
A. J. MORRIS (Cranfield Institute of Technology, England) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 393-406. refs

Attention is given to current practices in the CAD generation of minimum weight structure designs. The definition of design variables essentially fixes the form of the objective function; the remainder of the design problem is defined by the constraints limiting the range of values to be taken by the design variables in order to describe a realistic and safe structure. In the case of aircraft, loads are complex and give rise to a nonconservative system, due to the transmission of forces to the structure as a function of the deformed position and the structural/aerodynamic damping. O.C.

A86-33258
VARIATION OF ANISOTROPIC BEHAVIOUR IN STRUCTURAL OPTIMIZATION
G. HORNUNG, D. W. MATHIAS, and H. ROEHRLE (Dornier GmbH, Friedrichshafen, West Germany) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 407-414.

The 'gradient method' optimization procedure is presented with attention to results obtained by it for the optimization of a laminate composite wing box structure by which all design constraints are satisfied and weight is at its minimum. Prescribed restrictions in this procedure are restraints with respect to the failure of the laminate layers and the minimum thickness of the layers. The first part of the optimization process selects appropriate fiber orientations for a given structure under a given load; the second part improves this configuration by varying layer thicknesses until optimum design is obtained. O.C.

A86-33259
TAILORING METHODOLOGY FOR AEROELASTIC STABILITY AND LATERAL CONTROL ENHANCEMENT
T. A. WEISSHAAR (Purdue University, West Lafayette, IN) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 415-425. refs

Aeroelastic tailoring introduces directional stiffness into an aircraft structural design to control static or dynamic aeroelastic deformation so that aerodynamic and structural performance is affected in a beneficial manner. Utilization of the tailoring concept is often suggested, but has not been widely applied. This paper illustrates the problems and the potential of aeroelastic tailoring. Passive stability enhancement is shown to involve a compromise since, for fixed-root airfoils, maximizing flutter speed tends to minimize divergence speed and vice versa. Specific examples are included in the paper and involve both forward swept wing (FSW) and aft swept wing configurations. Nondimensional tailoring parameters are identified, independent of actual laminate geometry. The problem of tailoring for lateral control effectiveness is also reviewed for sweptback wings. Author

A86-33261
ANISOTROPIC WING AEROELASTIC THEORIES WITH WARPING EFFECTS
G. A. OYIBO and J. H. BERMAN (Fairchild Republic Co., Farmingdale, NY) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 434-440. refs

The aeroelastic equivalent of the aerodynamic similarity rule is used in an investigation of the influence of warping (spanwise axial constraints on wing twist) on anisotropic wing aeroelastic oscillations. The results obtained indicate that a high aspect ratio anisotropic wing should behave aeroelastically as a low aspect ratio wing, and vice-versa. Similarity parameters are derived and it is noted that the parameter currently used to determine when warping becomes significant is inaccurate for the case of anisotropic wings. The correct parameter is presented. O.C.

A86-33263
EFFECTS OF ANISOTROPIC DESIGN ON THE STATIC AEROELASTICITY OF A SWEPT WING
M. PIENING (DFVLR, Institut fuer Strukturmechanik, Brunswick, West Germany) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 451-456. refs

By exploiting the directional stiffness properties of composite materials coupling between different deformation modes can be achieved. The capability to apply this potential as design parameter is generally known as AEROELASTIC TAILORING. Although the utilization of the tailoring concept is often suggested in the context with the renewed interest in a forward swept wing it is generally applicable to improve the aircraft performance within the flight envelope. A simple structural idealization is adopted to model an arbitrary swept anisotropic wing of moderate to high aspect ratio. The related differential equations are solved for the deformations and internal forces by multiple shooting. The divergence speed is calculated by searching the lowest eigenvalue of the structural matrix formed from the transfer matrices of the wing sections and the according boundary conditions. Some parametric evaluations are performed. Author

A86-33264
AEROELASTIC PROBLEMS AND STRUCTURAL DESIGN OF A TAILLESS CFC-SAILPLANE
J. SCHWEIGER, O. SENSBURG (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany), and H. J. BERNS (Braunschweig, Technische Universitaet, Brunswick, West Germany) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 457-467. refs

Current structural optimizations programs, such as FASTOP and TSO, are presently applied to the redesign of a carbon fiber-reinforced composite tailless sailplane configuration. These programs obtained optimum reinforcing fiber orientations and stiffness distributions that met both aeroelastic and strength requirements. Flutter speed was doubled as a result of the design changes identified by this work, which encompassed wing root geometry modifications, a new main spar design, and the use of a novel, high modulus fiber type. O.C.

A86-33267
STRUCTURAL DYNAMIC ASPECTS OF ROTOR NODAL ISOLATION
J. STOPPEL (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 486-494.

Attention is given to the practical test results obtained in recent work with the antiresonance isolation system for helicopters designated 'ARIS'; this passive nodal isolation system employs

an antiresonant frequency that is tuned to the main rotor passage frequency to prevent the transmission of the oscillatory hub forces and moments to the fuselage. Finite element methods are presently used to model the effectiveness of an ARIS for the case of the BK 117 helicopter. In this way, both eigenvalue analysis and frequency response potential vibration problems can be predicted. O.C.

A86-33280
DETERMINATION OF NATURAL VIBRATION PROPERTIES OF A WING WITH WINGLET BY EXPERIMENTAL MODE SYNTHESIS TECHNIQUE
S. N. GU, W. J. YOU, and J. S. JIANG (Northwestern Polytechnical University, Xian, People's Republic of China) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 605-611. refs

Electrical measurements and laser time-averaged holographic interferometry supplemented by sand-contour methods are used to determine the nine lowest natural frequencies and their corresponding natural modes on a wing with winglet. The six lowest natural modes of the wing and the three lowest ones of the winglet are orthogonalized, and a three-dimensional quantitative analysis and orthogonalization of the three lowest natural modes are carried out. Also noted are a method for controlling the density of fringes on images reconstructed from the time-averaged holograms, and an analytical method for the orthogonalization of measured modes. O.C.

A86-33281
RAPID VIBRATION MODE ANALYSIS OF AIRCRAFT WITH EXTERNAL STORES
M. KARPEL (Israel Aircraft Industries, Ltd., Tel Aviv) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 612-616. refs

N86-22563*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
COMPARISON OF MEASURED AND CALCULATED TEMPERATURES FOR A MACH 8 HYPERSONIC WING TEST STRUCTURE
R. D. QUINN and R. A. FIELDS Mar. 1986 140 p refs
(NASA-TM-85918; H-1271; A-85137; NAS 1.15:85918) Avail: NTIS HC A07/MF A01 CSCL 01C

Structural temperatures were measured on a hypersonic wing test structure during a heating test that simulated a Mach 8 thermal environment. Measured data are compared to design calculations and temperature predictions obtained from a finite-difference thermal analysis. Author

N86-22564# Department of the Air Force, Washington, D.C.
AIRCRAFT WINDOW CLAMPING DEVICE Patent Application
J. H. DEOMS, inventor (to Air Force) 16 Oct. 1985 13 p
(AD-D011999; US-PATENT-APPL-SN-788189) Avail: NTIS HC A02/MF A01 CSCL 13E

An aircraft window clamping ring is used to hold an optical sensor window against an aircraft wall. The ring has a plurality of cantilevers having upper contacts that bear directly down on the window. Because of the flexibility in the vertical direction, thermal expansion is compensated for by movement of the cantilevers. Horizontal expansion of the window creates no additional stress because the upper contacts bear perpendicular to possible horizontal movement. The cantilevers can be designed to preload the window to take into account maximum thermal expansion. Author (GRA)

N86-22565# Joint Publications Research Service, Arlington, Va.
USSR REPORT: TRANSPORTATION
12 Mar. 1986 92 p Transl. into ENGLISH from various Russian articles
(JPRS-UTR-86-004) Avail: NTIS HC A05/MF A01

Transportation issues in the Soviet Union are reported. Topics discussed include: civil aviation, rail systems, maritime and river fleets, ports and transshipment centers, and intersector network development.

N86-22567# Joint Publications Research Service, Arlington, Va.
MORE ON NEW IL-96, IL-114 AIRCRAFT
V. INOZEMTSEV *In its* USSR Report: Transportation (JPRS-UTR-86-004) p 9-11 12 Mar. 1986 Transl. into ENGLISH from Nedelya (Moscow, USSR), no. 46, 11-17 Nov. 1985 p 8
Avail: NTIS HC A05/MF A01

The development of the Ilyushin Aircraft IL-96, the long range Russian airbus, is discussed. The airbus is reminescent of the IL-86, however, its dimensions are larger and the wing span is almost 10 m greater, and the tail fin is 2 m higher. The IL-96 is a two-decked aircraft, which can hold 300 passengers. The lower deck houses 15 standard baggage handling containers. The IL-96-300 is designed to make long flights, with two or three landings in a day. The design of the 60 seat IL-114 passenger turboprop is also described. Its cruising speed is 500 km/hr, and has two multiblade gas turbine engines. It has high aircraft efficiency. It has built-in ramps. It serves short and medium distances. E.A.K.

N86-22568# Joint Publications Research Service, Arlington, Va.
TUPOLEV BUREAU DEVELOPING TU-204 PASSENGER JET: TUPOLEV ON FEATURES
A. A. TUPOLEV and N. DOMBKOVSKIY *In its* USSR Report: Transportation (JPRS-UTR-86-004) p 12-16 12 Mar. 1986 Transl. into ENGLISH from Trud (Moscow, USSR), 3 Jan. 1986 p 4
Avail: NTIS HC A05/MF A01

The design and development of the TU-204 passenger jet is discussed. The latest methods in aerodynamics, engine construction, materials science and manufacturing were incorporated in the design. The cabin has more comfortable seats and wider aisles, and the aircrafts can carry 124 passengers. The TU-204 will replace the TU-154 passenger transport plane. The plane has an on-board computer system which will reduce the number of crew members to two or three. E.A.K.

N86-22569# Joint Publications Research Service, Arlington, Va.
DETAILS OF NEW KA-126 HELICOPTER
I. ANDREYEV *In its* USSR Report: Transportation (JPRS-UTR-86-004) p 17-19 12 Mar. 1986 Transl. into ENGLISH from Izvestiya (Moscow, USSR), 29 Jan. 1986 p 1
Avail: NTIS HC A05/MF A01

The development and construction of the Ka-126 agricultural helicopter is discussed. The Ka-126 is a modification of the older Ka-26 helicopter. The helicopter is equipped with one gas-turbine engine and its characteristics are enumerated. The economy and profitability of the helicopter are outlined. The Ka-126 is not influenced by low temperatures so that is can be utilized during the winter months. E.A.K.

N86-22570# Joint Publications Research Service, Arlington, Va.
CHINA REPORT: SCIENCE AND TECHNOLOGY
20 Feb. 1986 59 p refs Transl. into ENGLISH from various Chinese articles
(JPRS-CST-86-007) Avail: NTIS HC A04/MF A01

Progress in science and technology in the People's Republic of China is reported. Topics discussed include research and development in: computer sciences, applied sciences, acoustics, electronics, physics, and radiation protection.

N86-22572# Joint Publications Research Service, Arlington, Va.
IMPROVED Y-7, Y-12 AIRCRAFT DESCRIBED
S. BU *In its* China Report: Science and Technology (JPRS-CST-86-007) p 27-29 20 Feb. 1986 Transl. into ENGLISH from Hangkong Zhishi (Beijing, China), no. 12, Dec. 1985 p 3
Avail: NTIS HC A04/MF A01

The improved designs of the Y-7 and Y-12 aircrafts are described. The electronic equipment on the Y-7 was converted. The equipment included: environmental control system, atmospheric data system, ultrashortware radio station, magnetic navigation reference and attitude reference system, Omega navigation system, weather radar, guidance system, ranging device, and bearing receiver. The noise level was reduced. The interior of the Y-12 was changed and noise and vibration were reduced. The exterior was coated with high quality paint. E.A.K.

N86-22573# Joint Publications Research Service, Arlington, Va.
DETAILS OF Y-121 STOL AIRCRAFT PRESENTED
Z. SONG *In its* China Report: Science and Technology (JPRS-CST-86-007) p 30-32 20 Feb. 1986 refs Transl. into ENGLISH fdrom Hangkong Zhishi (Beijing, China), no. 12, Dec. 1985 p 4-5
Avail: NTIS HC A04/MF A01

The Y-121 is a newly developed, twin-engine turboprop, short take-off and landing multifunction airplane. It can be used for transportation, parachuting and for various applications in geology, agriculture and forestry; it can also be converted into a special-purpose airplane for precision search operation. The development design features, and technical performance of the Y-121 STOL aircraft are described. E.A.K.

N86-23585 Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt (West Germany).
STANDARDIZED FATIGUE LOADING SEQUENCES FOR HELICOPTER ROTORS (HELIX AND FELIX). PART 1: BACKGROUND AND FATIGUE EVALUATION. PART 2: FINAL DEFINITION OF HELIX AND FELIX
D. SCHUETZ, H. G. KOEBLER, W. SCHUETZ (Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn, West Germany), M. HUECK (Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn, West Germany), J. B. DEJONGE (NLR, Emmeloord, Netherlands), A. A. TENHAVE (NLR, Emmeloord, Netherlands), F. OCH (Messerschmitt-Boelkow-Blohm G.m.b.H., Munich, West Germany), G. DASKE (Messerschmitt-Boelkow-Blohm G.m.b.H., Munich, West Germany), P. R. EDWARDS, comp. (RAE, Farnborough, England), J. DARTS, comp. (RAE, Farnborough, England) et al. 1985 235 p refs Sponsored by Bundesministerium fuer Forschung und Technologie
(LBF-FB-167; IABG-TF-1425/1; IABG-TF-1425/2; NLR-TR-84043-U-PT-1; NLR-TR-84043-U-PT-2; RAE-TR-84084; RAE-TR-84085; ISSN-0721-5320) Avail: Issuing Activity

The Helix and Felix standard loading sequences for the main rotors of helicopters with articulated and semirigid rotors respectively are described. The definition of Helix and Felix, statistical content according to different counting methods, and the results of fatigue tests used to assess them are outlined. The defined form of the two standards is given in full length and shortened versions. The method of generation is extremely simple, although a considerable amount of data is required for the generation algorithm. A FORTRAN program for this purpose, together with complete data tables in the correct format, are presented. Author (ESA)

N86-23586*# Lightning Technologies, Inc., Pittsfield, Mass.
LIGHTNING PROTECTION GUIDELINES AND TEST DATA FOR ADHESIVELY BONDED AIRCRAFT STRUCTURES Final Report
J. E. PRYZBY and J. A. PLUMER Washington NASA Jan. 1984 175 p refs
(Contract NAS1-15884)
(NASA-CR-3762; NAS 1.26:3762; LT-83-155) Avail: NTIS HC A08/MF A01 CSCL 01C

The highly competitive marketplace and increasing cost of energy has motivated manufacturers of general aviation aircraft to utilize composite materials and metal-to-metal bonding in place of conventional fasteners and rivets to reduce weight, obtain smoother outside surfaces and reduce drag. The purpose of this program is protection of these new structures from hazardous lightning effects. The program began with a survey of advance-technology materials and fabrication methods under consideration for future designs. Sub-element specimens were subjected to simulated lightning voltages and currents. Measurements of bond line voltages, electrical sparking, and mechanical strength degradation were made to comprise a data base of electrical properties for new technology materials and basic structural configurations. The second hase of the program involved tests on full scale wing structures which contained integral fuel tanks and which were representative of examples of new technology structures and fuel systems. The purpose of these tests was to provide a comparison between full scale structural measurements and those obtained from the sub-element specimens. Author

N86-23587*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
MINIMUM TIME AND FUEL FLIGHT PROFILES FOR AN F-15 AIRPLANE WITH A HIGHLY INTEGRATED DIGITAL ELECTRONIC CONTROL (HIDEC) SYSTEM
E. A. HAERING, JR. and F. W. BURCHAM, JR. Jun. 1984 25 p refs
(NASA-TM-86042; H-1242; NAS 1.15:86042) Avail: NTIS HC A02/MF A01 CSCL 01C

A simulation study was conducted to optimize minimum time and fuel consumption paths for an F-15 airplane powered by two F100 Engine Model Derivative (EMD) engines. The benefits of using variable stall margin (uptrim) to increase performance were also determined. This study supports the NASA Highly Integrated Digital Electronic Control (HIDEC) program. The basis for this comparison was minimum time and fuel used to reach Mach 2 at 13,716 m (45,000 ft) from the initial conditions of Mach 0.15 at 1524 m (5000 ft). Results were also compared to a pilot's estimated minimum time and fuel trajectory determined from the F-15 flight manual and previous experience. The minimum time trajectory took 15 percent less time than the pilot's estimate for the standard EMD engines, while the minimum fuel trajectory used 1 percent less fuel than the pilot's estimate for the minimum fuel trajectory. The F-15 airplane with EMD engines and uptrim, was 23 percent faster than the pilot's estimate. The minimum fuel used was 5 percent less than the estimate. Author

N86-23588*# Computer Sciences Corp., Hampton, Va.
IMPROVEMENTS TO THE FATOLA COMPUTER PROGRAM INCLUDING ADDED ACTIVELY CONTROLLED LANDING GEAR SUBROUTINES Final Report
G. H. MALL Apr. 1983 217 p
(Contract NAS1-16078)
(NASA-CR-166069; NAS 1.26:166069; TAO-33842) Avail: NTIS HC A10/MF A01 CSCL 01C

Modifications to a multi-degree-of-freedom flexible aircraft take-off and landing analysis (FATOLA) computer program, including a provision for actively controlled landing gears to expand the programs simulation capabilities, are presented. Supplemental instructions for preparation of data and for use of the modified program are included. Author

N86-23589# Hover Systems Federal Corp., Eddystone, Pa.
AFTER ACTION REPORT, CH-47 RECOVERY USING D-PAAC Report, 13 - 21 Jul. 1985
Jul. 1985 29 p
(Contract DAAK70-85-C-0014)
(AD-A161935) Avail: NTIS HC A03/MF A01 CSCL 13B

On 12 July 1985, a request was made for use of the D-PAAC in a recovery operation for a crashed CH-47D, which had crashed in a fish and wildlife management area on the New Jersey shore near the Delaware river. Recovery operations were to be conducted with minimal damage to the environment and as quickly as possible. This report will cover the period from 13 to 21 July and will address the period in three sections. The first will cover preparation and movement from Duck, N.C., to Chester, Pa. The second will cover preparation at Chester, Pa., and movement to the crash site. The third will cover operations at the crash site and movement out of the area. The D-PAAC operated on cushions at all times. the concept of using air cushion craft for heavy lift recovery operations in terrain which offers no other accessibility was partially validated. Also, the feasibility of towing an air cushion vehicle over water by conventional tug in an inland waterway operation was proven. It must also be concluded that improved propulsion means are required as well as some self-recovery capability (on-board winch) to improve useability of future craft similiar to the D-PAAC. GRA

N86-23590# Naval Research Lab., Washington, D. C.
ELECTROSTATIC CHARGING OF THE CH-53E HELICOPTER
R. E. PECHACEK, J. R. GREIG, D. P. MURPHY, and J. SPELZ
29 Nov. 1985 48 p
(Contract F41-411)
(AD-A161936; NRLMR-5676) Avail: NTIS HC A03/MF A01 CSCL 01C

The effects of electrostatic charging on the CH-53E helicopter were examined. Measurements were made over a clean runway and over sandy terrain in basically desert conditions where electrostatic charging is known to be a problem. While the measured charging current (up to approx. 75 microAmp) and open circuit voltages (up to approx. 140 kV) cannot be claimed as maximum values attainable by the CH-53E, they show that the CH-53E is affected by electrostatic charging in much the same way as all other helicopters. Furthermore the range of data recorded in these tests has allowed us to formulate a model for the electrostatic charging of a hovering helicopter in both clean air and sandy air situations. This model is consistent with our own data and recorded prior experience with electrostatic charging of helicopters. It predicts that the CH-53E can readily attain short circuit currents of approx. 300 microAmp and open circuit voltages of approx. 400 kV. GRA

N86-23591# Army Science Board, Washington, D.C.
THE US ARMY'S LHX (LIGHT HELICOPTER FAMILY) PROGRAM Final Report, 1983 - 1984
W. L. HARRIS, J. BLAIR, G. F. DECKER, and R. L. MCDANIEL
Dec. 1984 50 p
(AD-A161949) Avail: NTIS HC A03/MF A01 CSCL 01C

Observations, analysis, conclusions and recommendations of the AHSG on selected critical issues related to the Army's LHX aircraft program are described. The basis of LHX, LHX program management, technology risk assessment, speed, and one versus two-man flight crew are discussed in the initial sections of this report. These issues constitute the more fundamental aspects of the Army's LHX program which were reviewed by the AHSG. Primary and secondary conclusions and recommendations are presented. Finally, a discussion of specific technologies and Army aviation programs is given in the appendices to this report. The discussion of each of these technologies and programs includes the AHSG's recommendations and conclusions on the same. A set of attachments follows the appendices. GRA

N86-23593# Naval Postgraduate School, Monterey, Calif.
A SYSTEMS ENGINEERING METHODOLOGY FOR THE ADVANCED TACTICAL AIRCRAFT M.S. Thesis
S. J. KAPURCH Sep. 1985 89 p
(AD-A162049) Avail: NTIS HC A05/MF A01 CSCL 05A

The increasing specialization of the aerospace industry coupled with the technical complexity of new systems has caused emphasis to be placed on a systematic and logical methodology to design, develop, and produce new products. A systems engineering model to integrate functional management areas with organizational activities in the Advanced Tactical Aircraft program is presented. Special emphasis is placed in applying this systems approach throughout the life cycle of a project. A general methodology and a synopsis of principles are provided which might be utilized in the development of a systems engineering program. GRA

N86-23594# Sikorsky Aircraft, Stratford, Conn. Sikorsky Aircraft Div.
ADVANCED TECHNOLOGY HELICOPTER LANDING GEAR PRELIMINARY DESIGN INVESTIGATION Final Report, 1983 - 1984
D. LOWRY Oct. 1985 135 p
(Contract DAAK51-83-C-0040; DA PROJ. 1L1-62209-AH-76)
(AD-A162097; SER-510148; USAAVSCOM-TR-85-D-4) Avail: NTIS HC A07/MF A01 CSCL 01C

A preliminary design investigation has been performed to develop weight and cost sensitivities of various landing gear systems for a 10,000-pound class LHX helicopter. Weights are established for three baseline main landing gear systems: a noncrashworthy retractable, a crashworthy retractable, and a crashworthy fixed. Each system is capable of kneeling the LHX helicopter. Weights are based on preliminary structural analysis of landing gear loads developed by a computer program KRASH. KRASH was used to obtain the design loads at various sink rates, and pitch and roll attitudes. The design loads were used to size the landing gear structure in order to develop the landing gear weight for the different impact conditions. Main landing gear system costs are developed from the weight data established. An aerodynamic drag assessment was performed. Criteria for crashworthy designs are recommended. The recommended criteria were developed from the weight trends, costs, and UH-60A Class A Mishaps. GRA

N86-23595# Sverdrup Technology, Inc., Arnold Air Force Station, Tenn.
ANALYSIS AND VERIFICATION OF THE ICING SCALING EQUATIONS. VOLUME 1 Final Report, 1 Aug. 1981 - 31 Mar. 1984
G. A. RUFF Nov. 1985 80 p Sponsored by Air Force
(AD-A162226; AEDC-TR-85-30-VOL-1) Avail: NTIS HC A05/MF A01 CSCL 17B

The formation of ice on aircraft surfaces occurs during flight through supercooled droplets. Ice accretions on these surfaces usually degrade both aircraft performance and operational safety. For this reason, it has become important in the design and certification phases of system development to evaluate system performance degradation because of icing. A research program was conducted to evaluate the icing scaling requirements. The objectives of the study were (1) to evaluate the equations governing the icing process to identify proposed scaling parameters, (2) to develop a computer code to solve the various forms of the icing scaling equations, (3) to conduct tests to determine which, if any, of the proposed methods produced scale ice accretions, and (4) if an accurate set of icing scaling equations were found, to write a final computer code that could be used in icing tests. The scaling verification tests were conducted using full and half-scale circular cylinders and full, 1/3, and 1/6-scale airfoil sections. GRA

N86-23774# Joint Publications Research Service, Arlington, Va.
ROLLOUT OF XT-4 INTERMEDIATE CLASS TRAINING AIRCRAFT
In its Japan Report: Science and Technology (JPRS-JST-86-007) p 1-5 25 Mar. 1986 Transl. into ENGLISH from Aerospace Japan (Tokyo, Japan), Jun. 1985 p 31-33
Avail: NTIS HC A04/MF A01

The completion of an XT-4 intermediate class training aircraft is reported. The XT-4 is a high-performance training aircraft produced entirely in Japan. The work of matching its engine and airframe will begin and the airframe will be subjected to functional tests. It will then be subjected to in-house tests and it will be delivered to the Defense Agency and tested for 2 years. Its scheduled completion is set for 2 years. The XT-4 has excellent flight characteristics at a wide variety of speeds. It is equipped with transonic wings, and the airframe shape is modified. The XT-4 is a training aircraft, and is scheduled to be used for flight training, however, it is an excellent aircraft with performance and characteristics suitable for Japan's needs. It is outstanding for rate of climb and range performance. E.A.K.

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A86-29864#
EVALUATION OF FORMATS FOR AIRCRAFT CONTROL/DISPLAY UNITS
T. L. MANN and L. A. LEIKER (Lockheed-Georgia Co., Marietta) IN: Symposium on Aviation Psychology, 3rd, Columbus, OH, April 22-25, 1985, Proceedings . Columbus, OH, Ohio State University, 1985, p. 135-142. refs

In this preliminary study of the definition of an optimal control/display unit display format design which will ensure effective and efficient human performance in the cockpit environment, subjects visually searched alphanumeric displays for a single unit of information and indicated when it was found. Data was thus collected on the accuracy of information retrieval, as well as the elaspsed time to isolate the information; ten formats of two information densities each were evaluated, each of which contained labels and associated data for typical flight data and communications data. The results obtained indicate that both format design and density affect operator response time and accuracy. Implications of these findings are discussed. O.C.

A86-30312#
FLUIDIC GYRO SYSTEMS
T. B. TIPPETTS (Garrett Corp., Garrett Pneumatic Systems Div., Tempe, AZ) IN: Symposium Gyro Technology 1985; Proceedings of the Symposium, Stuttgart, West Germany, September 24, 25, 1985 . Stuttgart/Duesseldorf, Universitaet Stuttgart/Deutsche Gesellschaft fuer Ortung und Navigation, 1985, p. 13.0-13.51. refs

Fluidic gyroscopic technology can operate under conditions so severe as to prohibit any alternative form of stability augmentation; it, in addition, possesses reliability, storability, and cost benefits over those alternatives that render it applicable to low cost strap-on systems for bombs, direct fire rockets, etc. Fluidic gyros are both EMI- and EMP-proof. Fluidic gyro output signals can be processed by fluidic amplifier, resistor and capacitor circuits, all of which are immune to EMP. Attention is given to applications, sensor operating principles, construction methods, and fluidic amplification/dynamic processing circuits. O.C.

A86-30315#
A LASER-INERTIAL AIRBORNE SURVEYING SYSTEM
J. W. HURSH (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: Symposium Gyro Technology 1985; Proceedings of the Symposium, Stuttgart, West Germany, September 24, 25, 1985 . Stuttgart/Duesseldorf, Universitaet Stuttgart/Deutsche Gesellschaft fuer Ortung und Navigation, 1985, p. 17.0-17.23. refs

The recently developed Aerial Profiling of Terrain System (APTS) furnishes terrain profiling and other survey data at current accuracy standards and with substantial savings in time and field work. APTS incorporates a three-gimbaled inertial platform to indicate aircraft position in three coordinates; a two-axis laser tracker mounted on a common base acquires and follows prelocated retroreflectors in sequence, thereby supplying range and pointing data to update the navigation on the basis of ground truth. The laser profiler provides terrain clearance measurements which are combined with the highly accurate position data from the navigation, in postflight data reduction, to obtain ground profiles. Attention is given to the considerations that most influenced system configuration, as well as the design and fabrication of the APTS hardware. O.C.

A86-31343
AIRBORNE RADAR - THE GREATER WATERSHED
J. PELLANDINI Interavia (ISSN 0020-5168), vol. 41, March 1986, p. 263, 265.

Three major combat aircraft radar development efforts are currently underway in France: (1) 'RDM', a multifunction, multimode pulse Doppler radar that is fully digital and monopulse, and which employs a frequency-agile coherent transmitter to accomplish many different missions; (2) 'RDI', a pulse Doppler radar optimized for long range interception of oncoming targets at any altitude; and (3) 'Antilope 5', which is designed to allow either simultaneous or separate mapping and terrain following in low altitude penetration missions in all weathers. The present evaluation of these technologies gives attention to methods for the circumvention of electronic countermeasures through ever increasing processing rates for ever increasing quantities of data. O.C.

A86-32099#
INSTRUMENTATION OF A LIGHT TWIN AIRCRAFT FOR FLOW ENERGIZER FLIGHT TESTS
D. T. WARD and R. S. BINFORD (Texas A&M University, College Station) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 15 p. refs
(AIAA PAPER 86-9759)

Flow energizers represent small lifting surfaces which are added to an aircraft with the objective to alter local flow characteristics. Typically, flow energizers are simpler to manufacture than the fillets, fairings and cuffs which they replace. The present paper is concerned with flow energizers which involve very low aspect ratio configurations, usually having a highly swept leading edge of approximately 75 degrees. Attention is given to pressure port locations on the wind tunnel model, flow energizer terminology, basic flight instruments, angle of attack and sideslip angle, surface pressure instrumentation, wake flow field instrumentation, force and moment instrumentation, integration of instrumentation, pressure data results, wake survey results, and force and moment results. G.R.

A86-32126#
THE NDS 2000 FLIGHT TEST INSTRUMENTATION SYSTEM IN THE F-20 TIGERSHARK
B. DEMO (Northrop Corp., Hawthorne, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p.
(AIAA PAPER 86-9797)

Northrop Flight Test has developed a modular, distributed, airborne data acquisition system, incorporating several unique technological advances. These include: digital signal processing of analog measurands; self-contained reference junction

compensation and integrating A to D conversion for thermocouples; a module to embed compressed digitized voice in the data stream; and a flexible and powerful MIL-STD-1553 bus interface. Author

A86-32128#
AFFTIS - WHAT NOW?
M. F. LAMY (SCI Technology, Inc., Huntsville, AL) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 5 p.
(AIAA PAPER 86-9799)

The 'AFFTIS' flight test instrumentation system was developed after January of 1983 in order to meet the requirements of a standardized approach to aircraft flight test program data acquisition requirements. Although AFFTIS was cancelled in September of 1985, a number of prepossessing technologies and system concepts were developed by the time of termination; it is to these that attention is presently given. Design details and performance projections are presented for the AFFTIS 10-Mbit full duplex serial bus, the AFFTIS System Controller's programmable secondary outputs and integral data processor, data acquisition units, signal conditioning, and ground and laboratory support systems. O.C.

A86-32140#
AIRBORNE INFRARED MEASUREMENT SYSTEMS AND TECHNIQUES
W. G. KULLER and M. E. STEBLIN (USAF, Eglin AFB, FL) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 9 p. refs
(AIAA PAPER 86-9814)

Information regarding aircraft infrared signatures is now needed in the design of new weapon systems, and the determination of such signatures requires the conduction of measurements with airborne infrared instrumentation. This paper provides information regarding available airborne systems needed by the test community, taking into account the various test techniques used to employ them. Attention is given to the beam approach seeker evaluation system (BASES), a supersonic airborne infrared measurement system (SAIMS), upgrades to BASES, the Infrared Calibrated Airborne Spatial Measurement System (IR CASMS), a SAIMS upgrade, and the self-contained airborne system ASIMS. In a description of test techniques, aircraft/drones are considered along with flares, missile performance, countermeasures, end-game tracking, and the determination of seeker acquisition envelopes. G.R.

A86-32144#
F-16 FLUTTER TESTING AT EGLIN AIR FORCE BASE
C. A. DREYER and D. L. SHOCH (USAF, Eglin AFB, FL) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 7 p.
(AIAA PAPER 86-9819)

As combat aircraft reach higher operational limits, while incorporating lighter and less rigid materials in their structures, flutter testing assumes greater importance. Attention is presently given to the flutter flight testing program conducted for the F-16 fighter at the U.S. Air Force's Eglin Air Force Base Armament Division. The tests were conducted with external stores in order to establish external store carriage limits. The instrumentation installed in the test aircraft and the premission calibration procedures required to insure accuracy in the data obtained are described, together with the means by which external stores are instrumented. O.C.

N86-22574*# Charles River Analytics, Inc., Cambridge, Mass.
A PRELIMINARY DESIGN FOR FLIGHT TESTING THE FINDS ALGORITHM Final Report
A. K. CAGLAYAN and P. M. GODIWALA Mar. 1986 85 p refs
(Contract NAS1-17719)
(NASA-CR-178043; NAS 1.26:178043; R8602) Avail: NTIS HC A05/MF A01 CSCL 01D

This report presents a preliminary design for flight testing the FINDS (Fault Inferring Nonlinear Detection System) algorithm on a target flight computer. The FINDS software was ported onto the target flight computer by reducing the code size by 65%. Several modifications were made to the computational algorithms resulting in a near real-time execution speed. Finally, a new failure detection strategy was developed resulting in a significant improvement in the detection time performance. In particular, low level MLS, IMU and IAS sensor failures are detected instantaneously with the new detection strategy, while accelerometer and the rate gyro failures are detected within the minimum time allowed by the information generated in the sensor residuals based on the point mass equations of motion. All of the results have been demonstrated by using five minutes of sensor flight data for the NASA ATOPS B-737 aircraft in a Microwave Landing System (MLS) environment. Author

N86-22575# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.
COMPARATIVE EVALUATION OF REDUNDANT FLIGHT DATA RECORDED BY A DIGITAL AIRBORNE INTEGRATED DATA SYSTEM RECORDER (DAR) ON BOARD AN AIRBUS A-310 AIRCRAFT
O. WEBER and G. ROSENAU 1985 42 p refs
Avail: NTIS HC A03/MF A01

Flight data collected during scheduled Airbus A-310 flights by a Digital AIDS Recorder (DAR) were analyzed. The characteristics of the standard A-310 AIDS are compared to those of the A-300 AIDS. The A-310 reconstruction of the motion state of the aircraft is more complete than with the older equipment. The DAR A-310 permits a detailed and extensive check of the basic AIDS measuring channels through independently measured quantities. This check, however, is restricted to the measuring ranges encountered in normal flight conditions. It cannot be extrapolated to extreme flight conditions expected in accidents or incidents. In the flight conditions of the scheduled flights, the correspondence between basic AIDS measurements and quantities from the extended AIDS is very good. Author (ESA)

N86-23596# Air Force Human Resources Lab., Brooks AFB, Tex.
LOGISTICS ENGINEERING ANALYSIS TECHNIQUES FOR FAULT-TOLERANT AVIONICS SYSTEMS Final Report, Mar. 1982 - Mar. 1984
J. C. MCMANUS Nov. 1985 59 p
(Contract F33615-82-C-0002)
(AD-A161981; AFHRL-TR-84-60) Avail: NTIS HC A04/MF A01 CSCL 01D

A technique which performs reliability, supportability, and survivability (RSS) analysis of fault-tolerant, dynamically reconfigurable systems during early design is presented. Implemented in the MIssion REliability Model (MIREM) computer program, this method analyzes the structure of functional components in a system. Use of MIREM will allow design engineers to apply RSS analysis before the design is fixed. GRA

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A86-30093
SHORT CRACK PROBLEMS IN GAS TURBINE DISKS
J. DREXLER and J. STATECNY (Vyzkumny a Zkusebni Letecky Ustav, Prague, Czechoslovakia) IN: Advances in fracture research (Fracture 84). Volume 5 . Oxford and New York, Pergamon Press, 1986, p. 3541-3547.

Methods of detecting a short crack at its first occurrence are described. The crack detection ability level of a human operator is evaluated. The probability characteristics of short cracks are discussed; an example displaying the probability of detecting a short crack at its first occurrence in a blade fir-tree attachment of a gas turbine disk is presented. The estimation of life gain to safe crack occurrence, based on the equation of Nemec and Dexler (1984), is examined and an example is provided. I.F.

A86-30737#
MODELLING AN AXIAL FLOW COMPRESSOR IN STARTING OF A TURBOJET ENGINE
D. YAN (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 6, Oct. 1985, p. 467-473. In Chinese, with abstract in English. refs

A method of modelling an axial-flow compressor in low speed starting regime from windmilling to idling of an engine is presented. A structural formula for the model is established according to Deyou (1983). A method of step-by-step regression is proposed for determining the coefficient matrices of the structural formula. The coefficient functions are determined on the basis of the square, linear, and constant terms of the mass flow coefficient respectively in the mathematical model, while in each portion of the regression the rotor speed is considered to approach zero due to the feature of very low speeds. In results the model represents the performance of the compressor at low speeds very well. Good agreement is obtained between the computational and experimental results. Author

A86-30740#
EXPERIMENTAL INVESTIGATION ON FREQUENCY RESPONSE OF A TURBOJET ENGINE TO TURBULENCE-TYPE DYNAMIC DISTORTION
S. LIU, F. CHEN, W. LI, Z. WANG, and M. CONG (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 6, Oct. 1985, p. 484-488. In Chinese, with abstract in English.

The inlet and exit fluctuating pressure signals of a compressor prior to 'drift surge' are investigated by correlation and spectral analyses. It is found that the stochastic process of fluctuating pressure is no longer stationary near the inception of the 'drift surge'. The surge of the tested engine under the dynamic distortion is caused by rotating stall. The whole unsteady operating time for the engine to approach surging is about 5 seconds and the process is characterized by rotating stall cell spreading forward from the rear stage over the whole annular passage of the compressor. It is worth noticing that the tested engine is sensitive to pressure fluctuations with certain frequencies prior to the surge, but a strict conclusion needs further experimental investigation. Author

A86-31328#
HOW TO NOT EAT YOUR OWN DUST
B. FRISCH Aerospace America (ISSN 0740-722X), vol. 24, Feb. 1986, p. 18, 19.

Design techniques useful for configuring particle filters for turbine engine air intakes are discussed and illustrated with descriptions of hardware in use or under development. Inertial particle separators have shown promise for the best, and most acceptable, performance in terms of low maintenance, effectiveness and ease of deicing. Vaneless separators (VS) in particular also feature reduced erosion, weight and part count. Contoured walls direct incoming particles to a scavenger duct in VSs when the flow has to accelerate over a hump, then turn. Because of inertia the particles cannot make the turn and are thus scavenged in the direction they must take. CFD/CAD codes which encompass the separator geometry, flow characteristics and particle trajectories are being applied in designing VSs, which are now primarily of interest for the LHX helicopters. M.S.K.

A86-31349
BATTLE OF THE HUSHKITS - ALL QUIETER ON WESTERN FRONT
P. TURK Interavia (ISSN 0020-5168), vol. 41, March 1986, p. 311-314.

A development and implementation status evaluation is made of engine noise reduction technologies aiming at compliance with the FAA's FAR 36 noise level standards for older airliners' powerplants. The 'hushkits' that have been developed for high bypass turbofan engines incorporate acoustic lining materials employing microporous mesh, a metallic perforated plate, a metallic honeycomb structure, and a metallic solid back skin. DC-8 and B-707 airliners have been the primary recipients of these treatments; it has been found that substantially different hushkit designs must be developed for every on of the engine-type/airframe combinations encountered in service. O.C.

A86-31586#
LONGITUDINAL COMBUSTION INSTABILITIES IN RAMJET ENGINES IDENTIFICATION OF ACOUSTIC MODES
J. E. CRUMP, K. C. SCHADOW (U.S. Navy, Naval Weapons Center, China Lake, CA), V. YANG, and F. E. C. CULICK (California Institute of Technology, Pasadena) Journal of Propulsion and Power (ISSN 0748-4658), vol. 2, Mar.-Apr. 1986, p. 105-109. refs
(Contract AF-AFOSR-80-0265; AF TASK A3103100)

Longitudinal combustion instabilities in liquid-fueled ramjet engines have been investigated with attention focused on determination of the acoustic mode structures. Detailed pressure measurements, including both amplitude and phase, were made at ten positions spanning the length of the engine. The experimental data have been analyzed using two linear acoustic models. Four distinct modes were observed for various inlet/combustor combinations. These results help identify the mechanisms exciting low-frequency pressure oscillations in ramjet engines. Author

A86-31595*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AERODYNAMIC AND STRUCTURAL DETUNING OF SUPERSONIC TURBOMACHINE ROTORS
D. HOYNIAK (NASA, Lewis Research Center, Cleveland, OH) and S. FLEETER (Purdue University, West Lafayette, IN) (Structures, Structural Dynamics, and Materials Conference, 26th, Orlando, FL, April 15-17, 1985, Technical Papers. Part 2, p. 500-514) Journal of Propulsion and Power (ISSN 0748-4658), vol. 2, Mar.-Apr. 1986, p. 161-167. Previously cited in issue 13, p. 1850, Accession no. A85-30378. refs

A86-32120*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE NASA MODERN TECHNOLOGY ROTORS PROGRAM
M. E. WATTS and J. L. CROSS (NASA, Ames Research Center, Moffett Field, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 13 p. refs
(AIAA PAPER 86-9788)

Existing data bases regarding helicopters are based on work conducted on 'old-technology' rotor systems. The Modern Technology Rotors (MTR) Program is to provide extensive data bases on rotor systems using present and emerging technology. The MTR is concerned with modern, four-bladed, rotor systems presently being manufactured or under development. Aspects of

MTR philosophy are considered along with instrumentation, the MTR test program, the BV 360 Rotor, and the UH-60 Black Hawk. The program phases include computer modelling, shake test, model-scale test, minimally instrumented flight test, extensively pressure-instrumented-blade flight test, and full-scale wind tunnel test. G.R.

A86-32121#
VERIFICATION OF THE THRUST AND AIRFLOW MODEL OBTAINED FROM THE PERFORMANCE MODELLING PROCESS
J. L. JORDAN and W. G. SCHWEIKHARD (Kohlman Systems Research, Inc. Lawrence, KS) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 7 p.
(AIAA PAPER 86-9790)

This paper demonstrates that the performance modeling method produces an engine performance model which compares faavorably with a calibrated engine deck produced by the manufacturer for a specific engine. An analysis shows that the employment of a thrust run corrected nominal engine model as a basis for a performance analysis represents a viable method. Attention is given to details concerning the engine modeling process, the calibrated engine process, the performance modeling process, ground static thrust runs, and flight test comparisons. G.R.

A86-32956*# United Technologies Research Center, East Hartford, Conn.
DYNAMIC CHARACTERISTICS OF AN ASSEMBLY OF PROP-FAN BLADES
A. V. SRINIVASAN (United Technologies Research Center, East Hartford, CT), R. E. KIELB, and C. LAWRENCE (NASA, Lewis Research Center, Cleveland, OH) ASME, Transactions, Journal of Engineering for Gas Turbines and Power (ISSN 0022-0825), vol. 108, April 1986, p. 306-312. refs
(ASME PAPER 85-GT-134)

In contrast to conventional propellers, propfan blades are thin and highly swept-back, thereby giving rise to large bending and twisting deformations and complex vibratory characteristics. Aerodynamic performance depends on the extent of steady state deformation, and the aeroelastic response depends on the vibratory frequency and mode shape. Attention is presently given to the principal results of structural analyses for a five-bladed propfan assembly; these results are compared with test data. The results encompass both steady deformations and vibratory frequencies and mode shapes in a vacuum centrifugal environment. O.C.

A86-32957*# Pennsylvania State Univ., University Park.
INFLUENCE OF FRICTION DAMPERS ON TORSIONAL BLADE FLUTTER
A. SINHA (Pennsylvania State University, University Park), J. H. GRIFFIN (Carnegie-Mellon University, Pittsburgh, PA), and R. E. KIELB (NASA, Lewis Research Center, Cleveland, OH) ASME, Transactions, Journal of Engineering for Gas Turbines and Power (ISSN 0022-0825), vol. 108, April 1986, p. 313-318. refs
(ASME PAPER 85-GT-170)

This paper deals with the stabilizing effects of dry friction on torsional blade flutter. A lumped parameter model with single degree of freedom per blade has been used to represent the rotor stage. The well-known cascade theories for incompressible and supersonic flows have been used to determine the allowable increase in fluid velocity relative to the blade. It has been found that the effectiveness of friction dampers in controlling flutter can be substantial. Author

A86-33266
DYNAMIC ANALYSIS OF STRUCTURES WITH FLEXIBLE ROTORS
M. GERADIN and N. KILL (Liege, Universite, Belgium) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 477-485. refs

The paper describes the analytical tools developed for the structural dynamic analysis of machines with rotating parts such as aircraft engines. The finite element analysis is used for discretization, and the rotating parts are described using a three-dimensional formalism which includes in the kinetic energy expression the gyroscopic effects induced by the local changes of angular velocity produced by the deformation. The implementation of the formalism is specialized to the modelling of flexible rotors made of shafts and disks as it is typical for modern aircraft engines. The effectiveness of the component mode synthesis method to reduce the size of the system of equations is demonstrated in the specific case of systems made of rotating and fixed parts, governed by different sets of equations. Critical speed and stability analyses as well as unbalance response calculations are then performed by a sweeping procedure. As an illustration, the concepts presented are applied to the dynamic analysis of a high bypass ratio aircraft engine. Author

N86-22577# Department of the Air Force, Washington, D.C.
IGNITER ELECTRODE LIFE CONTROL Patent Application
J. C. SCOTT, inventor (to Air Force) 7 Oct. 1985 11 p
(AD-D012007; US-PATENT-APPL-SN-784986) Avail: NTIS HC A02/MF A01 CSCL 11C

The prevention of electrode material erosion by undercutting in the outer electrode shell of igniter electrodes of jet engine ignition systems is prevented by the application of an electrical insulation coating. The coating is applied to the surface of the outer electrode shell which faces the ceramic insulation around the center electrode where erosion patterns are known to occur. The insulation material is selected from electrical insulation substances such as oxides of aluminum, tungsten, magnesium, beryllium or zirconium by choosing a non-porous electrical insulating substance with thermal expansion characteristics approximately equalling those of the outer electrode shell. Since a typical outer electrode shell is composed of 446 stainless steel, an optimum choice for the electrical insulation coating is Al2O3 deposited with a coating thickness of between 5 and 10 mils. Author (GRA)

N86-22736# Joint Publications Research Service, Arlington, Va.
STATUE OF AIRCRAFT ENGINE RESEARCH AT NPU REVIEWED
In its China Report: Science and Technology (JPRS-CST-86-004) p 40-45 28 Jan. 1986 refs Transl. into ENGLISH from Guoji Hangkong (Beijing, China), no. 10, Oct. 1985 p 4-6
Avail: NTIS HC A06/MF A01

The aircraft engine research work at Northwest Polytechnic University is intended to satisfy the needs of national defense and the aviation industry on the one hand, and to serve China's economic development on the other. The efforts were devoted to the following two areas: (1) exploring advanced design methods of high-performance propulsion systems, studying new topics in jet propulsion technology, developing our experimental capabilities and striving to improve measurement techniques; and (2) providing wide range of technical services to the mechanical, power, energy exploration and local industries in the areas of product design, application of new technologies, and development of new energy sources. Modern jet propulsion technology is closely tied to state-of-the-art scientific development and the development of electronic computers; it has evolved from a single technical discipline to the combined study of many different disciplines. The areas of research are discussed briefly. Author

N86-23599# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
THROTTLE DEPENDENT FORCES: A PRIMER Final Report, Aug. 1982 - Nov. 1984
D. L. BOWERS Nov. 1985 129 p
(AD-A162939; AFWAL-TR-85-3055) Avail: NTIS HC A07/MF A01 CSCL 21E

An introduction to the broad area of throttle dependent forces for airbreathing aircraft, primarily subsonic to supersonic capable is provided. Basic concepts and examples are presented for subsonic, supersonic and transonic inlet and nozzle applications. Experimental and analytical determination of throttle-dependent forces is discussed, including approaches and potential problems. A final reference section of basic definitions is included for completeness. GRA

N86-23601# Pratt and Whitney Aircraft, West Palm Beach, Fla. Engineering Div.
FRACTURE MECHANICS OF MULTIPLE CRACK INITIATIONS. AN APPLICATION FOR FRACTURE MECHANICS ANALYSIS OF GAS TURBINE ENGINE DISKS Interim Report, Feb. 1981 - Jun. 1983
B. A. COWLES, A. B. THAKKER, and G. E. KING Oct. 1985 44 p
(Contract F33615-80-C-5160; DARPA ORDER 3993)
(AD-A162998; PW/ED/FR-18778; AFWAL-TR-85-4110) Avail: NTIS HC A03/MF A01 CSCL 21E

The purpose of this task was to investigate the current life prediction methodology for multiple crack growth in gas turbine engine components. To this end, experimental and analytical efforts were carried out. Current prediction methods for very small cracks (as small as 0.005 x 0.010 inches) were modified to address the larger interacting cracks produced by the controlled-preflaw methods used in this program. The authors conclude that: (1) The modified crack growth life prediction technique currently in use resulted in acceptable but conservative predictions in all cases. Variability in the predictions was also acceptable and was similar to variability in predicted versus actual results for singular crack cases. (2) The multiple-degree-of-freedom approach also produced acceptable life predictions and, in fact, demonstrated reduced variability in predicted versus actual results. It was, however, more complicated to use and did not result in a consistent conservative bias in the life predictions. (3) Based on this study, the modified crack growth life prediction technique currently in use is considered adequate for Retirement-for-Cause applications. The multiple-degree-of-freedom approach offers potential improvements for future use. GRA

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AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A86-30499* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DIRECTIONAL HANDLING QUALITIES REQUIREMENTS FOR NAP-OF-THE-EARTH TASKS
C. C. BIVENS (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) American Helicopter Society, Journal (ISSN 0002-8711), vol. 31, Jan. 1986, p. 37-42. refs

A piloted similator experiment designed to investigate directional axis handling qualities requirements for low-speed and hover tasks conducted by a scout/attack helicopter is described. Included were the directional characteristics of various candidate light helicopter family (LHX) configurations. The test also focused on conventional single main/tail rotor configurations where the first-order effects that contribute to the loss of tail rotor control experienced by the OH-58 series aircraft were modeled. Two types of yaw stability and control augmentation systems were implemented: washed-out yaw rate feedback and shaped control input, and a yaw rate command, heading-hold system. The results of the experiment indicate that rotorcraft configurations with high directional gust sensitivity require more yaw damping to maintain satisfactory handling qualities during nap-of-the-earth (NOE) flying tasks. It was also determined that both yaw damping and control response are critical handling qualities parameters in performing the air-to-air target acquisition and tracking task. The lack of substantial yaw damping and larger values of gust sensitivity increased the possibility of loss of directional control at low airspeeds for the tail rotor configurations. Author

A86-30925
THE AEROMECHANICS OF AIRCRAFT: FLIGHT DYNAMICS (2ND REVISED AND ENLARGED EDITION) [AEROMEKHANIKA SAMOLETA: DINAMIKA POLETA /2ND REVISED AND ENLARGED EDITION/]
A. F. BOCHKAREV, ED. and V. V. ADREEVSKII, ED. Moscow, Izdatel'stvo Mashinostroenie, 1985, 360 p. In Russian. No individual items are abstracted in this volume. refs

A handbook for aviation students on the physics of flight is presented. Among the specific topics discussed are: the equations of motion governing aircraft in flight; aircraft trajectory calculations; and methods for calculating nonlinear or quasi-linear flight regimes. The issues of aircraft stability and control are addressed, with emphasis given to: aerodynamic moment calculations; static lateral stability; and stability constraints in nonlinear flight regimes. Topics concerning the dynamics of perturbed flight regimes are also discussed, including: pitching moment perturbations; corkscrew motion; and lateral moment perturbations. I.H.

A86-31125
FREQUENCY-DOMAIN APPLICATION OF GAUSS-NEWTON METHOD TO EXTRACT AIRCRAFT LONGITUDINAL PARAMETERS
S. C. RAISINGHANI (Indian Institute of Technology, Kanpur, India) and A. K. GOEL (Defence Research and Development Laboratory, Hyderabad, India) Aeronautical Journal (ISSN 0001-9240), vol. 90, Jan. 1986, p. 27-34. refs

The Gauss-Newton (GN) method is successfully applied in the frequency domain to extract aircraft longitudinal stability and control parameters from simulated flight data in calm air. Flight data at 128 points are generated and analyzed for six different types of elevator control inputs using the example of a business-jet aircraft. The initial values of the parameters are set arbitrarily at 0.5 to 1.5 times the true values to demonstrate the strength of the algorithm. Pseudorandom numbers are used to generate noisy data, and the present output error method is shown to yield good estimates even in the presence of high intensity measurement noise. It is demonstrated that the frequency-domain algorithm of the GN method is capable of giving better results as compared to the time-domain algorithm, and could achieve this in reduced computational time. R.R.

A86-31660*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
INFLUENCE OF HIGH-ORDER DYNAMICS ON HELICOPTER FLIGHT-CONTROL SYSTEM BANDWIDTH
R. T. N. CHEN (NASA, Ames Research Center, Moffett Field, CA) and W. S. HINDSON (Stanford University, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, Mar.-Apr. 1986, p. 190-197. Previously announced in STAR as N85-21174. refs

The increasing use of highly augmented digital flight-control systems in modern military helicopters prompted an examination of the influence of the influence of rotor dynamics and other high-order dynamics on control-system performance. A study was conducted at NASA Ames Research Center to correlate theoretical predictions of feedback gain limits in the roll axis with experimental test data obtained from a variable-stability research helicopter. Feedback gains, the break frequency of the presampling sensor

filter, and the computational frame time of the flight computer were systematically varied. The results, which showed excellent theoretical and experimental correlation, indicate that the rotor-dynamics, sensor-filter, and digital-data processing delays can severely limit the usable values of the roll-rate and roll-attitude feedback gains. R.J.F.

A86-31661#
AN INTERPRETATION OF AIRPLANE GENERAL MOTION AND CONTOL AS INVERSE PROBLEM
O. KATO and I. SUGIURA (Nagoya University, Japan) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, Mar.-Apr. 1986, p. 198-204. refs

A theoretical study for the inverse problem of the airplane general motion, that is, the problem of how an airplane should be controlled, when its flight maneuver is given, is described. An interpretation of this problem is made, and a general and practical method to solve the problem is developed. The distinctive features of this approach are to transform all the state variables of the airplane motion into the functions of the angle of attack alpha, sideslip angle beta and bank angle phi, and to pay special attention to the distinction between the flight-path angles and the flight attitude angles. By treating the triplet (alpha, beta, phi) as key variables it becomes easy to have insight into this complicated problem. This approach is applicable not only to conventional methods of motion and control but also to new and unusual methods through consideration of the degree of freedom of (alpha, beta, phi) for a given maneuver. A numerical calculation of an interesting flight maneuver is presented and discussed to illustrate the problem. Author

A86-31662*# Waterloo Univ. (Ontario).
TRANSIENT MOTION OF A HYPERSONIC WEDGE, INCLUDING TIME HISTORY EFFECTS
W. H. HUI (Waterloo, University, Canada) and H. J. VAN ROESSEL Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, Mar.-Apr. 1986, p. 205-212. NSERC-supported research. Previously cited in issue 7, p. 857, Accession no. A85-19585. refs
(Contract NAGW-575)

A86-32084*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
REAL-TIME OPEN-LOOP FREQUENCY RESPONSE ANALYSIS OF FLIGHT TEST DATA
J. T. BOSWORTH (NASA, Flight Research Center, Edwards, CA) and J. C. WEST (USAF, Flight Test Center, Edwards AFB, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 11 p. refs
(AIAA PAPER 86-9738)

A technique has been developed to compare the open-loop frequency response of a flight test aircraft real time with linear analysis predictions. The result is direct feedback to the flight control systems engineer on the validity of predictions and adds confidence for proceeding with envelope expansion. Further, gain and phase margins can be tracked for trends in a manner similar to the techniques used by structural dynamics engineers in tracking structural modal damping. Author

A86-32114*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLIGHT INVESTIGATION OF A MULTIVARIABLE MODEL-FOLLOWING CONTROL SYSTEM FOR ROTORCRAFT
K. B. HILBERT, J. V. LEBACQZ (NASA, Ames Research Center, Moffett Field, CA), and W. S. HINDSON (Stanford University, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 14 p. refs
(AIAA PAPER 86-9779)

A high-bandwidth, multivariable, explicit model-following control system for advanced rotorcraft has been developed and evaluated on the NASA Ames CH-47B fly-by-wire helicopter. This control system has expanded the in-flight simulation capabilities of the CH-47B to support research efforts directed at the next generation of superaugmented helicopters. A detailed, analytical model of the augmented CH-47B has also been developed to support the flight tests. Analysis using this theoretical model was used to expose fundamental limitations caused by the basic vehicle characteristics and original control system implementation that had affected the performance of the model-following control system. Improvements were made to the nominal control system design to compensate for large time delays created by the higher-orderd dynamics of the aircraft and its control system. With these improvements, high bandwidth control and excellent model-following performance were achieved. Both analytical and flight-test results for the lateral axis are presented and compared. In addition, frequency-domain techniques are employed for documenting the system performance. Author

A86-32136#
MANAGEMENT CONTROLS ON THE X-29 FLIGHT-CONTROL SYSTEM SOFTWARE DEVELOPMENT
N. J. FURIA (Grumman Corp., Aircraft Systems Div., Bethpage, NY) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p.
(AIAA PAPER 86-9808)

Software management systems for the X-29 forward-swept-wing aircraft are described. Emphasis is given to a description of the Operational Flight Program (OFP) controlling all aerodynamic surfaces on the aircraft. Other important functions of the OFP include built-in-test (BIT), redundancy management, and fault reaction. The OFP hardware consists of a triple-redundant dual processor. An air-data function controls the input of air-data parameters (static and dynamic pressure) which are used to calculate a predetermined set of gains for control of Mach number, altitude, and angle of attack. Verification and validation tests were accomplished by several independent engineering teams and independent review teams have been organized to assess the test coverage. A functional block diagram of the OFP top-level hierarchy is provided. I.H.

A86-32139*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DEVELOPMENT OF SPIN RESISTANCE CRITERIA FOR LIGHT GENERAL AVIATION AIRPLANES
D. J. DICARLO, H. P. STOUGH, III, K. E. GLOVER, P. W. BROWN, and J. M. PATTON, JR. (NASA, Langley Research Center, Hampton, VA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 10 p. refs
(AIAA PAPER 86-9812)

A brief history of stall/spin technology for light general aviation airplanes is presented. Criteria needed to describe desirable characteristics of a spin-resistant airplane and means to evaluate airplanes for compliance with the criteria have been developed. Initial results from limited flight tests of an experimental high-wing airplane indicated that the basic configuration would not meet the spin resistance criteria. Further tests with the airplane modified to enhance its spin resistance are planned. Author

A86-32146#
FIRST USE OF ADA IN FLIGHT-CRITICAL AVIONICS
M. D. BASS (McDonnell Aircraft Co., St. Louis, MO) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 7 p.
(AIAA PAPER 86-9822)

Ada higher-order computer software language was selected for application in an aircraft flight-critical avionic subsystem. The F-15 Control Augmentation System was modified from an analog system to a digital system, then programmed in Ada and tested throughout the aircraft flight envelope. This was the first use of Ada in flight hardware. The digital flight control system programmed in Ada performed nearly identical to the standard F-15 analog system. The suitability of Ada for use in military aircraft flight-critical

avionics has thus been demonstrated. This paper discusses the test conduct and test results obtained, and describes the test aircraft modification. Author

A86-32657
STABILITY OF A NONLINEAR STOCHASTIC SYSTEM UNDER PERIODIC EXCITATION [USTOICHIVOST' ODNOI NELINEINOI STOKHASTICHESKOI SISTEMY PRI EE PERIODICHESKOM VOZMUSHCHENII]
I. D. CHERKASOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela (ISSN 0572-3299), Jan.-Feb. 1986, p. 65-68. In Russian. refs

A stochastic Liapunov function is used to find stability conditions for a stochastic model of the vibrations of a helicopter rotor blade with allowance for horizontal turbulent fluctuations of the air velocity. The stochastic stability region of the system (in the weak sense) is established using the results of an earlier study (Khasminskii, 1969). The stability of the system in the strong sense and the asymptotic weak stability of the stochastic system in the absence of periodic excitation are also discussed. V.L.

A86-33178
ADAPTIVE FLIGHT CONTROL OF UNSTABLE HELICOPTERS DURING TRANSITION
H. OHTA, S. YOKOKURA (Nagoya University, Japan), P. N. NIKIFORUK, and M. M. GUPTA (Saskatchewan, University, Saskatoon, Canada) IN: A bridge between control science and technology. Volume 2 . Oxford and New York, Pergamon Press, 1985, p. 1045-1050. Research supported by the Ministry of Education of Japan. refs
(Contract NSERC-A-5625; NSERC-A-1080)

The design of an adaptive control system for a helicopter during transitional flight conditions is discussed. A mathematical model of the controlled plant and a model reference adaptive system (MRAS) is described. The identification speed and control performance of the system are examined. Simulation studies that reveal the problems associated with the identification and control techniques are presented. An adaptive algorithm based on MRAS and developed using the discrete Kalman filter is proposed. Stability derivative data are employed to predict the time-varying characteristics of the parameters. Examples displaying the applicability of the adaptive flight control system are provided. I.F.

A86-33180
A DISCRETE ADAPTIVE OBSERVER FOR A MULTI-OUTPUT AIRCRAFT CONTROL SYSTEM
N. HORI, P. N. NIKIFORUK (Saskatchewan, University, Saskatoon, Canada), and K. KANAI (Defense Academy, Yokosuka, Japan) IN: A bridge between control science and technology. Volume 2 . Oxford and New York, Pergamon Press, 1985, p. 1057-1062. refs

A state feedback system is described for controlling the longitudinal motion of an unknown aircraft using an adaptive observer applicable to multi-output systems. This observer is a simple extension of the single-output case and does not require the decomposition of the system. The design of the overall control system is, therefore, as simple as that for single-variable systems. For purposes of clarification, a singular control problem is investigated, but not the closed loop stability. Author

A86-33246
FLUTTER CALCULATION BY A NEW PROGRAM
V. J. E. STARK (SAAB-Scania AB, Linkoping, Sweden) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 276-285. Research supported by the Forsvaret Materielverk anad SAAB-Scania AB. refs

A new flutter and response program based on general equations of motion is described. The equations are solved by Laplace transformation and by mainly reducing the inversion integral to a sum of the residues at the poles at the zeros of the determinant. The resulting nonlinear eigenvalue problem, i.e. the problem of finding the zeros, is solved by using the Newton-Raphson formula combined with efficient numerical methods for calculation of the determinant and the principle of the argument for finding initial approximations. The program permits choice of different kinds of analytic functions in the linear approximation that is employed for approximating the aerodynamic transfer functions. Equations representing control laws of a flutter suppression system can be included. Author

A86-33248* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DEVELOPMENT OF A FLUTTER SUPPRESSION CONTROL LAW BY USE OF LINEAR QUADRATIC GAUSSIAN AND CONSTRAINED OPTIMIZATION DESIGN TECHNIQUES
W. M. ADAMS, JR. and S. H. TIFFANY (NASA, Langley Research Center, Hampton, VA) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 297-308. refs

A control law is developed to suppress symmetric flutter for a mathematical model of an aeroelastic research vehicle. An implementable control law is attained by including modified LQG (Linear Quadratic Gaussian) design techniques, controller order reduction, and gain scheduling. An alternate (complementary) design approach is illustrated for one flight condition wherein nongradient-based constrained optimization techniques are applied to maximize controller robustness. Author

A86-33249
FINITE STATE MODELLING OF AEROELASTIC SYSTEMS FOR ACTIVE CONTROL APPLICATIONS - A GENERAL THEORY
R. VEPA (Queen Mary College, London, England) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 309-319. refs

In this paper various techniques of modelling aeroelastic systems for active control applications are described. Three different approaches are available for this purpose and these are (1) the autonomous finite state approach (2) the time varying system approximation (3) the differential delay model. The differential delay model seems to be the simplest method of modelling aeroelastic systems. A design procedure for synthesizing optimal control laws for regulator design using the differential model is also briefly described. Author

A86-33250
NLR EXPERIENCE IN THE APPLICATION OF ACTIVE FLUTTER SUPPRESSION AND GUST LOAD ALLEVIATION, APPLIED TO A WIND-TUNNEL MODEL
P. A. VAN GELDER (National Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 320-329. Research supported by the Nederlands Instituut voor Vliegtuigontwikkeling en Ruimtevaart and Nationaal Lucht- en Ruimtevaartlaboratorium. refs

In 1981, the National Aerospace Laboratory of the Netherlands started a research program to study the aeroelastic effects of active control systems. Control laws for flutter suppression and gust load alleviation systems were developed and tested using an aeroelastic wind-tunnel model in a subsonic wind tunnel with the capability to simulate discrete or random gusts. Flutter suppression up to the maximum wind tunnel speed of 1.4 V(f) was achieved, while the gust load alleviation system reduced the wing root bending moment by 25 percent at 0.9 V(f) for simulated gusts with a Dryden spectrum. Author

A86-33251
THE DESIGN AND WIND TUNNEL DEMONSTRATION OF AN ACTIVE CONTROL SYSTEM FOR GUST LOAD ALLEVIATION AND FLUTTER SUPPRESSION
I. W. KAYNES, C. W. SKINGLE, and J. C. COPLEY (Royal Aircraft Establishment, Farnborough, England) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 330-347.

A86-33252
WINDTUNNEL TEST AND LABORATORY SIMULATION OF A LOAD ALLEVIATION SYSTEM FOR A MODERN TRANSPORT AIRCRAFT
H. G. GIESSELER and G. BEUCK (Messerschmitt-Boelkow-Blohm GmbH, Hamburg, West Germany) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 356-361.

MBB-UT has within the scope of government sponsored programs worked out the technological fundamentals for the development of an aircraft with a Load Alleviation System. The design and realization procedure, a possible sensor and actuating concept, the way how the control law was derived and a possible operational concept are explained. The design and mechanization of a digital LAS-controller is explained. The performance of the control law and of the digital hardware using a wind tunnel model is shown. A planned and partly realized laboratory simulation is presented, which enables us to verify the design conditions of the LAS in real hardware environment and using an aeroelastic model of the aircraft. Author

A86-33253
CONTROL LAW SYNTHESIS FOR GUST LOAD ALLEVIATION USING LINEAR QUADRATIC GAUSSIAN THEORY
J. CHANG (Northwestern Polytechnical University, Xian, People's Republic of China) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 362-367.

Linear quadratic Gaussian synthesis is presently applied to the design of a flexible aircraft's multiloop gust load alleviation system in which the one-dimensional vertical gust is approximately modelled as the output of a linear system with a stationary white noise process as the input. A technique yielding a minimal number of augmented states is presented, and, for all the coefficient matrices, a matrix least-squares formula is established. System states are estimated by means of a Kalman-Bucy filter observer, and a cost function involving the performance index of ride quality and control surface deflections with a weighting matrix is used. The time domain formula for the rms value of the normal acceleration associated with the aircraft response to gusts is given. O.C.

N86-22578 Tennessee Univ., Knoxville.
INVESTIGATION OF THE DYNAMIC RESPONSE OF AIRCRAFT TO MICROBURST (JAWS) WIND SHEAR Ph.D. Thesis
H. P. CHANG 1985 138 p
Avail: Univ. Microfilms Order No. DA8524117

A derivation of the governing equations of aircraft motion in variable wind field results in additional wind shear terms appearing in the force equations. Computer simulations of B727 type aircraft flying (landing and taking off) through the microburst (JAWS) wind shear data have been carried out and are in good agreement with those of the NASA/Ames B727 piloted simulator. The critical penetration heights through the center of the microburst are determined by computing the aircraft trajectory deviations from the intended flight path at the ILS Category 2 decision height window. It is found that the higher the magnitude of the wind gradient terms, the more influence they have on the aircraft performance, especially on sideslip angle, angle of attack, and rolling moment. The wind shear effects on three generic types of aircraft, a three-engine passenger airliner (PA), a twin-engines STOL (STOL), and an executive jet (EJ), are also investigated in this study. Dissert. Abstr.

N86-22579*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A METHODOLOGY FOR AIRPLANE PARAMETER ESTIMATION AND CONFIDENCE INTERVAL DETERMINATION IN NONLINEAR ESTIMATION PROBLEMS Ph.D. Thesis - George Washington Univ., Apr. 1985
P. C. MURPHY Apr. 1986 56 p refs Revised
(NASA-RP-1153; L-16009; NAS 1.61:1153) Avail: NTIS HC A04/MF A01 CSCL 01C

An algorithm for maximum likelihood (ML) estimation is developed with an efficient method for approximating the sensitivities. The ML algorithm relies on a new optimization method referred to as a modified Newton-Raphson with estimated sensitivities (MNRES). MNRES determines sensitivities by using slope information from local surface approximations of each output variable in parameter space. With the fitted surface, sensitivity information can be updated at each iteration with less computational effort than that required by either a finite-difference method or integration of the analytically determined sensitivity equations. MNRES eliminates the need to derive sensitivity equations for each new model, and thus provides flexibility to use model equations in any convenient format. A random search technique for determining the confidence limits of ML parameter estimates is applied to nonlinear estimation problems for airplanes. The confidence intervals obtained by the search are compared with Cramer-Rao (CR) bounds at the same confidence level. The degree of nonlinearity in the estimation problem is an important factor in the relationship between CR bounds and the error bounds determined by the search technique. Beale's measure of nonlinearity is developed in this study for airplane identification problems; it is used to empirically correct confidence levels and to predict the degree of agreement between CR bounds and search estimates. Author

N86-22580*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LOW-SPEED STABILITY AND CONTROL CHARACTERISTICS OF A TRANSPORT MODEL WITH AFT-FUSELAGE-MOUNTED ADVANCED TURBOPROPS
Z. T. APPLIN and P. L. COE, JR. Apr. 1986 67 p refs
(NASA-TP-2535; L-16004; NAS 1.60:2535) Avail: NTIS HC A04/MF A01 CSCL 01C

A limited experimental investigation was conducted in the Langley 4- by 7-Meter Tunnel to explore the effects of aft-fuselage-mounted advanced turboprop installations on the low-speed stability and control characteristics of a representative transport aircraft in a landing configuration. In general, the experimental results indicate that the longitudinal and lateral-directional stability characteristics for the aft-fuselage-mounted single-rotation tractor and counter-rotation pusher propeller configurations tested during this investigation are acceptable aerodynamically. For the single-rotation tractor configuration, the propeller-induced aerodynamics are significantly influenced by the interaction of the propeller slipstream with the pylon and nacelle. The stability characteristics for the counter-rotation pusher configuration are strongly influenced by propeller normal forces. The longitudinal and directional control effectiveness, engine-out characteristics, and ground effects are also presented. In addition, a tabulated presentation of all aerodynamic data presented in this report is included as an appendix. Author

N86-22581*# Information and Control Systems, Inc., Hampton, Va.
EXTENSIONS TO PIFCGT: MULTIRATE OUTPUT FEEDBACK AND OPTIMAL DISTURBANCE SUPPRESSION
J. R. BROUSSARD Mar. 1986 121 p refs
(Contract NAS1-17493)
(NASA-CR-3968; NAS 1.26:3968; IR-684105) Avail: NTIS HC A06/MF A01 CSCL 01C

New control synthesis procedures for digital flight control systems were developed. The theoretical developments are the solution to the problem of optimal disturbance suppression in the presence of windshear. Control synthesis is accomplished using a linear quadratic cost function, the command generator tracker for trajectory following and the proportional-integral-filter control structure for practical implementation. Extensions are made to the optimal output feedback algorithm for computing feedback gains so that the multirate and optimal disturbance control designs are computed and compared for the advanced transport operating system (ATOPS). The performance of the designs is demonstrated by closed-loop poles, frequency domain multiinput sigma and eigenvalue plots and detailed nonlinear 6-DOF aircraft simulations in the terminal area in the presence of windshear. E.A.K.

N86-22582*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE MEASUREMENT OF AIRCRAFT PERFORMANCE AND STABILITY AND CONTROL AFTER FLIGHT THROUGH NATURAL ICING CONDITIONS
R. J. RANAUDO, K. L. MIKKELSEN, R. C. MCKNIGHT, R. F. IDE, A. L. REEHORST, J. L. JORDAN, W. C. SCHINSTOCK, and S. J. PLATZ 1986 46 p refs Presented at the 3rd Flight Testing Conference, Las Vegas, Nev., 2-4 Apr. 1986; cosponsored by AIAA, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE Prepared in cooperation with Kohlman Systems Research, Inc., Lawrence, Kansas
(NASA-TM-87265; E-2962; NAS 1.15:87265; AIAA-86-9758)
Avail: NTIS HC A03/MF A01 CSCL 01C

The effects of airframe icing on the performance and stability and control of a twin-engine commuter-class aircraft were measured by the NASA Lewis Research Center. This work consisted of clear air tests with artificial ice shapes attached to the horizontal tail, and natural icing flight tests in measured icing clouds. The clear air tests employed static longitudinal flight test methods to determine degradation in stability margins for four simulated ice shapes. The natural icing flight tests employed a data acquisition system, which was provided under contract to NASA by Kohlman Systems Research Incorporated. This system used a performance modeling method and modified maximum likelihood estimation (MMLE) technique to determine aircraft performance degradation and stability and control. Flight test results with artificial ice shapes showed that longitudinal, stick-fixed, static margins are reduced on the order of 5 percent with flaps up. Natural icing tests with the KSR system corroborated these results and showed degradation in the elevator control derivatives on the order of 8 to 16 percent depending on wing flap configuration. Performance analyses showed the individual contributions of major airframe components to the overall degration in lift and drag. Author

N86-22583# European Space Agency, Paris (France).
ROBUSTNESS OF DISCRETE-TIME DYNAMICAL SYSTEMS: APPLICATION TO THE MULTIVARIABLE DIGITAL CONTROL OF COMBAT AIRCRAFT
Y. JOANNIC Oct. 1985 266 p refs Transl. into ENGLISH of "La Robustesse des Systemes Dynamiques a Temps Discret: Application au Pilotage Numerique Multivariable des Avions d'Armes" Rept. ONERA-NT-1984-2 ONERA, Paris, France, 1984 Original language document was announced as N85-19986
(ESA-TT-906; ONERA-NT-1984-2) Avail: NTIS HC A12/MF A01

A method for computing optimal feedback laws, capable of maintaining accurate tracking despite constantly acting disturbances was developed and applied to flight control of combat aircraft. A formalism reduces robustness to preservation of stability in a properly augmented system. This leads to theoretical results which quantify the generalized structural robustness of a recurrent nonlinear multiple-loop system. After extending the Lyapunov criterion to systems having dynamical feedback, the classical concepts of stability margin and of gain and phase margins are generalized to the multivariable discrete case. Analytical expressions which enable margins to be evaluated when dynamical or nonlinear perturbations affect the feedback channels are given. By applying theorems on external stability to a recurrent system, the tolerable additive perturbations which do not destabilize the controlled system are quantified. Author (ESA)

N86-23603*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DEVELOPMENT EXPERIENCE WITH A SIMPLE EXPERT SYSTEM DEMONSTRATOR FOR PILOT EMERGENCY PROCEDURES
M. VANNORMAN and D. A. MACKALL Feb. 1986 17 p refs
(NASA-TM-85919; H-1272; NAS 1.15:85919) Avail: NTIS HC A02/MF A01 CSCL 01C

Expert system techniques, a major application area of artificial intelligence (AI), are examined in the development of pilot associate to handle aircraft emergency procedures. The term pilot associate is used to describe research involving expert systems that can assist the pilot in the cockpit. The development of expert systems for the electrical system and flight control system emergency procedures are discussed. A simple, high-level expert system provides the means to choose which knowledge domain is needed. The expert systems were developed on a low-cost, FORTH-based package, using a personal computer. Author

N86-23604*# Tennessee Univ., Tullahoma. Atmospheric Science Div.
ANALYSIS OF DATA FROM NASA B-57B GUST GRADIENT PROGRAM Final Report
W. FROST, M. C. LIN, H. P. CHANG, and E. RINGNES Sep. 1985 500 p refs
(Contract NAS8-36177; NAS8-35347)
(NASA-CR-178736; NAS 1.26:178736) Avail: NTIS HC A21/MF A01 CSCL 01C

Statistical analysis of the turbulence measured in flight 6 of the NASA B-57B over Denver, Colorado, from July 7 to July 23, 1982 included the calculations of average turbulence parameters, integral length scales, probability density functions, single point autocorrelation coefficients, two point autocorrelation coefficients, normalized autospectra, normalized two point autospectra, and two point cross sectra for gust velocities. The single point autocorrelation coefficients were compared with the theoretical model developed by von Karman. Theoretical analyses were developed which address the effects spanwise gust distributions, using two point spatial turbulence correlations. B.G.

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RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A86-29916#
ADVANCED CONCEPTS FLIGHT SIMULATION FACILITY
S. L. CHAPPELL (Informatics General Corp., Moffett Field, CA) and G. A. SEXTON (Lockheed-Georgia Co., Marietta, GA) IN: Symposium on Aviation Psychology, 3rd, Columbus, OH, April 22-25, 1985, Proceedings . Columbus, OH, Ohio State University, 1985, p. 575-582.

Three identical Advanced Concepts Flight Simulation Facilities have been completed by NASA together with the Lockheed-Georgia Company. These simulation facilities, based on projected air travel

needs and technology available for flight by 1995, have three components: (1) the Advanced Concepts Flight Station (ACFS); (2) an integrated air traffic control simulation; and (3) experimenter/observer stations. The ACFS is based on a hypothetical wide-body composite airframe propelled by two turbo-fan engines that has a range of 2500 miles and carries 200 passengers. The optimized airframe design produces a negative static margin and relies upon a three-axis stability augmentation system for manual aircraft control. Features incorporated into its components include: voice-operated cathode ray tube displays of flight systems information, clearance print-outs, cockpit traffic displays, current datebases containing navigational charts, fuel-efficient autopilot control from takeoff to touchdown, and an outside visual scene withy variable weather conditions. It has been shown that this cockpit is a versatile test-bed for studying displays, controls, procedures, and crew management in a full-mission context. K.K.

A86-29917#
THE DEVELOPMENT OF AN ADVANCED HELICOPTER RESEARCH SIMULATOR
F. J. MALKIN (U.S. Army, Human Engineering Laboratory, Aberdeen Proving Ground, MD) IN: Symposium on Aviation Psychology, 3rd, Columbus, OH, April 22-25, 1985, Proceedings . Columbus, OH, Ohio State University, 1985, p. 585-589.

A helicopter flight simulator is developed which will be used as a research tool through which advanced controls and displays, and varying levels of automation will be evaluated in terms of their impact on human performance. The part task and total crew station/system environment simulation investigations include display formats and side-arm flight control considerations. The crew station accepts a variety of display devices, and control input schemes including key pads, a thumb-controlled joy stick for maneuvering the display cursor, and a speech recognition device. A low-cost computer-generated image system video-projects images onto a large screen. The experimenter's console will be used in the development, monitoring, and result analysis of experiments. Applications include the development of the LHX. R.R.

A86-31012#
THE EXTENSION OF THE MADEIRA AIRPORT RUNWAY - A UNIQUE TASK [LA PROLONGACION DE LA PISTA DE VUELO DE MADEIRA - UNA OBRA SINGULAR]
M. GARCIA CRUZADO (INTECSA; Escuela Tecnica Superior de Ingenieros Aeronauticos, Madrid, Spain) IAA/Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), Jan. 1986, p. 32-34. In Spanish.

The civil engineering undertaking which the extension of two runways (by respectively 50 and 150 m) at Madeira airport represented in 1982, in order to accommodate such aircraft as DC-9s and B727s, is presently discussed with attention to the accommodation of difficult terrain. The structures built are of steel-reinforced concrete and in the case of one of the two extensions employed a row of columns that extended to the sea shore. O.C.

A86-31124
THE 'MINITUFT' SURFACE FLOW VISUALISATION METHOD - EXPERIENCE OF USE IN THE RAE 5M PRESSURISED LOW-SPEED WIND TUNNEL
D. G. DOBNEY, P. HANSON, and S. P. FIDDES (Royal Aircraft Establishment, Aerodynamics Dept., Farnborough, England) Aeronautical Journal (ISSN 0001-9240), vol. 90, Jan. 1986, p. 10-17.

The development and use of a 'minituft' surface flow visualization technique in the RAE 5m Pressurized Low-Speed Wind Tunnel is described. The method, due to Crowder, uses very fine nylon monofilaments to show surface flow direction. These tufts are made visible by coating them in a fluorescent dye and then illuminating them with a powerful ultra-violet light source. Because of their small size, a large number of tufts may be used without interfering with the flow to a great extent. However, it is shown that if accurate force measurements are required, then it is advisable to test the model in the absence of tufts. Author

A86-31847*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THE NATIONAL TRANSONIC FACILITY
H. K. HOLMES (NASA, Langley Research Center, Hampton, VA) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 1, Feb. 1986, p. 1-7.

The National Transonic Facility, NTF, is a high Reynolds Number facility where the increase in Reynolds Number is obtained by operating at high pressures and low temperatures. Liquid nitrogen is allowed to vaporize, making gaseous nitrogen the test medium with temperatures extending down to approximately 100 degrees Kelvin. These factors have created unique, new challenges to those developing sensors and instrumentation. Pressure vessels, thermal enclosures or elaborate temperature compensations schemes, are needed for environmental protection and special materials are needed for sensors and model fabrication. The need for a new measurement, model deformation, was also created. An extensive program to develop the unique sensors and instrumentation was initiated. The data acquisition system and systems to measure aerodynamic forces and pressures, model attitude, and model deformation, are discussed. Author

A86-32089#
MISSION CONTROL FEATURES AT YUMA PROVING GROUND
R. MAI (U.S. Army, Analysis and Computation Branch, Yuma Proving Ground, AZ) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p.
(AIAA PAPER 86-9745)

An inventory is presented of the real time data collection, processing, and display capabilities that are available to test customers at the U.S. Army's Yuma Proving Ground (USAYPG) in Arizona, with emphasis on the information available for display in using USAYPG mission control rooms during typical aircraft navigation and aircraft armament testing. Information is categorized according to origin as video data, field instrumentation data, and telemetry data. USAYPG is unique among test ranges in its total integration of telemetry and field instrumentation data in a single, real time processing computer. O.C.

A86-32090#
THE MBB FLIGHT TEST CENTRE AND ITS FACILITIES
K.-H. BURGER (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 11 p.
(AIAA PAPER 86-9746)

This paper gives a summarizing introduction of the Flight Test Center of the Messerschmitt-Boelkow-Blohm Company (MBB), as it presents itself today. Starting with flight test organization, management and worksharing, the test facilities and test ranges are described. Emphasis is laid on flight monitoring, computer systems for analyses, and development of analysis software which may be used on-line to some extent. In this field MBB is preparing itself especially for the flight test program of the future fighter aircraft of the German Air Force. Finally a review about conducted flight test programs is given. Author

A86-32091#
TRACKING RADARS AT FLIGHT TEST RANGES
A. E. HOFFMANN-HEYDEN (RCA Missile Test Project, Patrick AFB, FL) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 10 p.
(AIAA PAPER 86-9747)

The paper reviews the evolution of operational tracking radars up to their current status, and their role in Test Range Instrumentation for measurements on flying targets. The major milestones of technical developments and the impact of digital computers are addressed and exemplified. Emphasis is placed on

the use of computers to achieve enhanced radar performance and a host of auxiliary refinements and capabilities through software programs. Among these, sophistication and automation of calibration techniques increased the accuracy capabilities of high-quality radar systems for the benefit and consistency of metric data acquisition in the Test Range environment. Author

A86-32092#
AIR FORCE FLIGHT TEST CENTER RANGE OVERVIEW
L. SMITH (USAF, Flight Test Center, Edwards AFB, CA) and E. RAMIREZ (USAF, Hill AFB, UT) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 6 p.
(AIAA PAPER 86-9748)

Over 75 percent of all Air Force Systems Command air vehicle testing is conducted at the Air Force Flight Test Center. In direct support of this activity are two instrumented ranges (the Air Force Flight Test Center and the Utah Test and Training Range) and a data acquisition and transmission corridor between them which stretches from Edwards AFB in southern California to Hill AFB in Utah. These terminal areas can function as separate entities or as a single range for extended flights. Data can be acquired in real-time in each area and by remote sites located along the microwave link between them. This paper addresses the Mission, Management, Resources and Future Plans for these ranges. Author

A86-32105#
COMPUTER GRAPHICS SUPPORT OF A NEW ERA IN FLIGHT TEST GROUND STATIONS
P. T. VESELY (Grumman Corp., Grumman Data Systems, Alverton, NY) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 7 p.
(AIAA PPER 86-9769)

The use of computer graphics in the flight testing of aircraft is examined. The performance and display characteristics of the Megatek 7255 and the Tektronix 4115B graphic engines are evaluated and compared. The Megatek 8255 is a higher performance terminal; however, the Tektronix has superior resolution and visual display area. The components and functions of the failure status monitor which utilizes color graphics to display detected failures are described. The new display and control system uses the Tektronix to produce high quality displays; the real-time graphics provided by the system are discussed. The operation of the mission display subsystem which provides time, space, and positioning information is studied. A layout of a data analysis station is presented. I.F.

A86-32135#
INTEGRATION TEST FACILITY FOR P3 AIRCRAFT PURPOSE AND USES
G. E. BURGESS (Lockheed-California Co., Burbank) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p.
(AIAA PAPER 86-9807)

The P3 Integration Test Facility (ITF), geared towards both the integration of newly updated aircraft systems, and the functional testing and support of existing production equipment, is described. ITF Update III programs include an Acoustic Processor System for the P3C, and complete replacement of the acoustic sensor station equipment for active and passive sonar. Other ITF support functions include, satellite communications development for Satcom, program tape duplication, acoustic processing of real world data, and data link checkout of all production aircraft prior to delivery to the Navy. In addition to its avionics mock-up, the facility includes a development and demonstration facility incorporating an aircraft metal fuselage, consoles, and racks. Other ITF-type facilities are found in Canada and Japan. R.R.

A86-32150#
RADAR CROSS SECTION TESTING
H. C. GARRETSON, III (USAF, Radar Target Scatter Div., Holloman AFB, NM) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 5 p.
(AIAA PAPER 86-9828)

This paper discusses Radar Cross Section testing. The U.S. Air Force Radar Target Facility (RATSCAT) at Holloman Air Force Base, New Mexico is described. The two ranges at RATSCAT, RATSCAT Main and RAMS (RATSCAT Advanced Measurement System) are presented. Management and test philosophy at RATSCAT are presented with discussions of a unique surge-concept Operations and Maintenance contract and an evolving analysis capability. Author

A86-33265
SIMULATION OF AIRCRAFT TAXI TESTING ON THE AGILE SHAKER TEST FACILITY
R. FREYMANN (DFVLR, Institut fuer Aeroelastik, Goettingen, West Germany) and W. P. JOHNSON (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 468-476. refs

The Aircraft Ground Induced Loads Excitation (AGILE) test facility is an array of three independent shakers which allow laboratory simulation of an aircraft taxiing on rough surfaces. It is shown how AGILE can be used in the dynamic qualification process and for verification of the mathematical structural model of an aircraft. Moreover, attention is focussed on experimental determination of the elastomechanical characteristics of aircraft landing gears and tires. Author

N86-22737# Joint Publications Research Service, Arlington, Va.
SHANGHAI'S OUTDOOR AEROENGINE TEST FACILITY DETAILED
In its China Report: Science and Technology (JPRS-CST-86-004) p 46-50 28 Jan. 1986 Transl. into ENGLISH from Hangkong Zhizao Gongcheng (Beijing, China), no. 7, 1 Jul. 1985 p 1-4
Avail: NTIS HC A06/MF A01

In November 1983, the outdoor test facility of the Shanghai Aircraft Engine Factory was officially certified by the technical certification conference sponsored by the National Defense Science and Engineering Committee, and was named the Shanghia Outdoor Test Facility for Aircraft Engines. As China's first outdoor test facility, it was designed to perform the essential functions of new engine development, verification of engine performance, establishing momentum corrections for indoor test facilities, and studying the effect of weather and environmental conditions on engine performance. Author

N86-23607# New Mexico Univ., Albuquerque. Engineering Research Inst.
RUNWAY RUBBER REMOVAL SPECIFICATION DEVELOPMENT: FIELD EVALUATION RESULTS AND DATA ANALYSIS Interim Report, Jul. 1984 - Jul. 1985
R. A. GRAUL and L. R. LENKE Jul. 1985 108 p refs
(Contract F29601-84-C-0080)
(FAA/PM-85/32; ESL-TR-85-63; NMERI-WA5-6(5.04)) Avail: NTIS HC A06/MF A01

The phenomenon of runway touchdown zone rubber buildup which is a potentially hazardous problem is discussed. The use of pavement surface texture measurements is capable of determining pavement friction levels. The use of four economical texture measurement techniques and their relationship to friction levels as determined by the Mu-Meter are discussed. Good correlations are obtained by relating pavement surface texture measurements of friction. However, predictive errors preclude the use of these models in lieu of friction measurements for use in rubber removal guidelines. E.A.K.

N86-23608# National Aeronautical Establishment, Ottawa (Ontario).
RECENT IMPROVEMENTS TO THE NAE 5 FT. X 5 FT. BLOWDOWN WIND TUNNEL
L. H. OHMAN, D. BROWN, A. J. BOWKER, and F. A. ELLIS Aug. 1985 41 p
(AD-A162034; NAE-AN-31; NRC-24882) Avail: NTIS HC A03/MF A01 CSCL 14B

Although the National Aeronautical Establishment (NAE) 5 ft x 5 ft Blowdown Wind Tunnel was conceived in the 1950's, with commissioning in 1962/63, it has stood the test of time very well and is still, in 1985, in heavy demand. Three main reasons for this situation are: (1) the basic wind tunnel design was fundamentally very sound; (2) the wind tunnel circuit and its auxiliary systems have frequently been improved and modernized so that it, even today, is a modern up-to-date facility; and (3) the high level of competence of the supporting staff. This report presents the major improvements made in recent years and the impact these have had on the performance of the facility. The improvements are: the rebuild of the settling chamber; the rebuild of the exhaust diffuser; the installation of active Mach number control for subsonic transonic operation; The incorporation of dual drive on the two-dimensional insert balance system; the suppression of edgetone noise; The incorporation of highly accurate digital pressure transducers; and the control and data processing system. Future plans for expanded use of the wind tunnel are outlined. GRA

N86-23609# General Accounting Office, Washington, D. C. Resources Community and Economic Development Div.
INFORMATION ON AIRPORT AND AIRWAY TRUST FUND REVENUES AND OUTLAYS BY STATES AND LARGE AIRPORTS
30 Sep. 1985 38 p
(PB86-129665; GAO/RCED-85-153; B-219969) Avail: NTIS HC A03/MF A01 CSCL 01A

The Airport and Airway Trust Fund was established to ensure that taxes collected from commercial air passengers, private pilots, and other sources are expended only for the expansion, improvement, and maintenance of the nation's air transportation system. Estimates by states and large airports of taxes paid into the trust fund are presented. Selected trust fund moneys received in fiscal years 1979 to 1983 are estimated. GAO's ability to fully estimate trust fund revenues and outlays by states and large airports was restricted by data limitations that required GAO to make several broad assumptions. The GAO notes that by law, the primary purpose of the trust fund is to ensure the safe operation of this nation's airspace system, not to provide an even or equitable return of the tax revenues to airports and states. Author

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ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A86-31348
AEROSPACE PLANES AND TRANS-ATMOSPHERIC VEHICLES - RECENT US STUDIES REVIVE DORMANT TECHNOLOGIES
B. SWEETMAN Interavia (ISSN 0020-5168), vol. 41, March 1986, p. 305-308.

A technology-readiness and performance prospects evaluation is made for next-generation large aircraft capable of reaching and sustaining hypersonic (Mach 5 and above) speeds with air breathing powerplants as well as of leaving the earth's atmosphere for Space Shuttle-like operations employing nonairbreathing propulsion. Both DARPA and NASA are currently sponsoring research in the materials, configuration design, propulsion and fuel systems, and control and navigation methods, that are entailed by such vehicles. Attention is given to cryogenically fueled 'air turboramjet' engine technology, which encompasses turbojet (low speed), ramjet (high speed), and rocket (exoatmospheric) propulsion cycles. O.C.

A86-32124#
REAL-TIME TELEMETERED INERTIAL GUIDANCE (TMIG) EVALUATION
R. H. THOMPSON (USAF, Western Space and Missile Center, Vandenberg AFB, CA) and R. B. PICKETT (ITT, Vandenberg AFB, CA) AIAA, AHS, CASI, DGLR, TES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 4 p.
(AIAA PAPER 86-9795)

A primary safety problem of the National Test Ranges is related to the detection of, and response to, test vehicle failures which might pose an unacceptable risk to life and property. The inertial guidance (IG) system can accurately sense many types of potentially dangerous in-flight vehicle failures, and the data provided by it are routinely telemetered in real time. The evaluation of these data is discussed. The TMIG data is currently used as a secondary or backup source until late in the flight when the radar displays become noisy or unreliable. However, the reliance on radar data as the prime source for range safety displays leads to important questions in some scenarios. A discussion of these questions led to the formation of a special TMIG committee. The most important findings of the committee are summarized. G.R.

A86-33299
STATISTICAL DYNAMICS AND CONTROL OPTIMIZATION OF FLIGHT VEHICLES [STATISTICHESKAIA DINAMIKA I OPTIMIZATSIIA UPRAVLENIIA LETATEL'NYKH APPARATOV]
A. A. LEBEDEV, V. T. BOBRONNIKOV, M. N. KRASILSHCHIKOV, and V. V. MALYSHEV Moscow, Izdatel'stvo Mashinostroenie, 1985, 280 p. In Russian. refs

The application of the stochastic theory of control to the analysis and synthesis of control systems for flight vehicles is presented in a systematic manner. Topics discussed include methods of statistical description of random quantities, processes, and fields; methods of a priori statistical analysis of the controlled motion of flight vehicles; methods of estimating the states of flight vehicles; and programming of the optimal control of flight vehicles. Attention is then given to the synthesis of the optimal control of flight vehicles and optimal control under conditions of incomplete information. V.L.

11

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A86-29972
FACTORS AFFECTING THE DESIGN OF MILITARY AIRCRAFT STRUCTURES IN CARBON FIBRE REINFORCED COMPOSITES
B. W. ANDERSON (British Aerospace, PLC, Aircraft Group, Preston, England) IN: Advances in fracture research (Fracture 84). Volume 1 . Oxford and New York, Pergamon Press, 1986, p. 607-622.

Some of major factors and philosophies relating to the introduction of carbon fiber-reinforced epoxy matrices are reviewed. The basic rules governing the design of new laminate materials are discussed, including control tapering, blocking minimization, envelope tailoring, and reversible load buckling. Some of the structural limitations of laminates in design applications for military aircraft are also considered. These limitations include:

preprocessing and postprocessing variations from design standards; manufacturing and impact defects; notches due to loaded and unloaded holes; and environmental limitations with respect to temperature and moisture. Experimental data on the performance of carbon fiber reinforced composites in realistic military aircraft loading environments are given in an appendix.
I.H.

A86-30006
SPECTRUM FATIGUE CRACK GROWTH BEHAVIOR OF ALUMINUM ALLOYS
G. R. CHANANI, G. V. SCARICH, A. A. SHEINKER (Northrop Corp., Aircraft Div., Hawthorne, CA), and P. E. BRETZ (Aluminum Company of America, Alcoa Center, PA) IN: Advances in fracture research (Fracture 84). Volume 3 . Oxford and New York, Pergamon Press, 1986, p. 1609-1621. Navy-sponsored research. refs

Constant amplitude and spectrum fatigue crack growth testing was performed on ten commercial 2000 and 7000 series aluminum alloy plate materials. The materials were selected to determine the effects of various alloying approaches including purity (fracture toughness) and temper (yield strength). Two different fighter aircraft spectra were used for testing; one represented the loading on a lower wing root and had predominantly tension loads, and the other represented a horizontal tail hinge and had high magnitude compression loads. Spectrum fatigue crack growth life did not correlate with yield strength and only correlated weakly with fracture toughness. In addition, tests were performed with a modification of one of the spectra to determine the effects of compressive loads. These tests showed that compressive loads in this complex, random spectrum significantly reduced the life. Nevertheless, the ranking of the materials was essentially the same for all three spectra.
Author

A86-30013
FATIGUE CRACK PROPAGATION FROM AN INCLINED CRACK UNDER COMBINED MODE LOADING
R. CHINADURAI, B. K. JOSHI (Civil Aviation Department, New Delhi, India), and R. K. PANDEY (Indian Institute of Technology, New Delhi, India) IN: Advances in fracture research (Fracture 84). Volume 3 . Oxford and New York, Pergamon Press, 1986, p. 1703-1710. refs

The experiments conducted in the context of the present study involved the employment of aluminum alloy and steel which are utilized as structural materials in aircraft. Attention is given to details of fatigue testing and evaluation, the fatigue crack growth profile and the crack propagation direction, the determination of the crack growth rate, the fatigue crack growth rate as a function of various parameters, the effect of crack angle and stress level on the cyclic life, the crack propagation angle, and a comparison of experimental and theoretical crack growth rates. It is found that the average direction of fatigue crack growth is independent of crack size and stress amplitude.
G.R.

A86-30030
FATIGUE BEHAVIOUR OF ADVANCED ALUMINIUM ALLOY LUGS OF 7475-T761 WITH AND WITHOUT INITIAL CRACKS
A. BUCH and A. BERKOVITS (Technion - Israel Institute of Technology, Haifa) IN: Advances in fracture research (Fracture 84). Volume 3 . Oxford and New York, Pergamon Press, 1986, p. 1983-1989. refs

7475 and 2024 Al-alloy lugs were tested under various test conditions. Spectrum and constant-amplitude tests showed that the total life of undamaged lugs of 7475-T761 aluminium alloy was not longer than that of conventional materials. This was probably because of the equally damaging effect of fretting in all materials compared. In the case of maneuver loading spectrum the crack propagation life of lugs with initial cracks was larger for the 7475-T761 lugs than for similar lugs made of 2024-T3.
Author

A86-30033
A WEAK BEAM TRANSMISSION ELECTRON MICROSCOPY STUDY OF A FATIGUE CRACK TIP IN A 2024 ALUMINUM ALLOY
K. RAJAN and R. L. HEWITT (National Aeronautical Establishment, Ottawa, Canada) IN: Advances in fracture research (Fracture 84). Volume 3 . Oxford and New York, Pergamon Press, 1986, p. 2025-2032. refs

Weak-beam dark field transmission electron microscopy has been used to study the dislocation structure at a fatigue crack tip in 2024 aluminum. The region immediately ahead of the crack tip is characterized by a dislocation cell structure. Changes in the localized stress level at the crack tip are monitored by the measurement of the distribution of bowed out dislocation segments near cell walls.
Author

A86-31475
MATERIALS AND PROCESSES; PROCEEDINGS OF THE FIFTH TECHNOLOGY CONFERENCE, MONTREUX, SWITZERLAND, JUNE 12-14, 1984. VOLUMES 1&2
Conference sponsored by the Society for the Advancement of Material and Process Engineering. Geneva, Switzerland, Society for the Advancement of Material and Process Engineering, 1985. Vol. 1, 185 p.; vol. 2, 191 p. No individual items are abstracted in these volumes.

The present conference on advanced aerospace materials gives attention to high performance thermoplastic matrix composites and their manufacturing techniques, the filament winding of complex components, the mechanized manufacture of FRP components for aircraft secondary structures, a novel high strain-to-failure prepreg, the manufacture of accurate glass and carbon fiber preforms for resin injection, a helicopter composite tail unit, Al-Li alloys, the durability of Arall, the potential weight savings obtainable in future transport aircraft through the use of advanced materials, superplastically formed Ti and Al alloys for aerospace applications, and assembly bonding with room temperature-curing adhesives. Also discussed are novel composite systems for use in primary aircraft structures, accelerated moisture absorption in carbon-epoxy, the thermoanalytic characterization of matrix resins and composites, the definition of microstructures in hybrid reinforced plastics, ceramic components for automotive powerplants, Kevlar-reinforced automotive components, metallized textile fabrics and their applications, and the role of S-2 glass fibers in advanced composites.
O.C.

A86-33021
MULTIPURPOSE CORROSION INHIBITORS FOR AEROSPACE ALLOYS IN NAVAL ENVIRONMENTS
V. S. AGARWALA (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: New materials and new processes. Volume 3. 1985 . Cleveland, OH, JEC Press, Inc., 1985, p. 178-189. refs

Principles of corrosion and corrosion control applicable to crack tips were considered to evolve a new approach for the inhibition of cracking in high strength steels and aluminum alloys. Chemical systems were formulated with multifunctional properties such that a synergistically combined inhibitor system could modify, in situ the interfacial chemistry of the crack. Laboratory experiments were conducted to investigate the effects of such inhibitors on stress corrosion cracking and corrosion fatigue behavior of 4340 and 300M steels and 7075-T6 aluminum alloy. The inhibitor system 'DNBM' showed a significant effect in retarding crack growth rate in the alloys tested and also enhanced the threshold, K(1scc), for the aluminum alloy. The most promising application for the multifunctional concept has proven to be a chemical conversion coating for aluminum alloys.
Author

A86-33088
ACOUSTIC-BACKSCATTERING STUDIES OF TRANSVERSE CRACKS IN COMPOSITE THICK LAMINATES
B. B. RAJU (Dayton, University, OH) Experimental Mechanics (ISSN 0014-4851), vol. 26, March 1986, p. 71-78. refs
(Contract F33615-83-5036)

The distribution of first-ply transverse cracks in graphite/epoxy 0.5-in. thick laminates was scanned by the acoustic-backscattering technique. The backscattering scans reveal a discrete number of characteristic dark bands in the case of specimens subjected to static loads or a low number of fatigue-load cycles. A dark band extending along the length of the specimen was obtained in specimens subjected to a high number of fatigue-load cycles. These dark bands reveal the three-dimensional distribution of transverse cracks situated in several adjacent planes. X-ray radiography shows the projection of the three-dimensional distribution of transverse cracks in the laminate plane and hence it may provide a low estimate of the distribution of transverse cracks in composite thick specimens. Author

A86-33223
DISPERSION STRENGTHENED P/M ALUMINIUM ALLOYS
I. B. MACCORMACK Metals and Materials (ISSN 0266-7185), vol. 2, March 1986, p. 131-134; 136, 137. refs

Attention is given to state-of-the-art techniques for the production of dispersoid phases in aluminum powder metallurgy base metal, with a view to the strength enhancement obtainable through the incorporation of a dispersion of fine intermetallic or nonmetallic particles. The merits of mechanical alloying, rapid solidification, and nonmetallic additions are assessed, with reference to both production parameters and prospective aerospace application requirements. The demand for superior mechanical properties at elevated temperatures in aerospace applications, however, cannot be fulfilled through dispersion strengthening of aluminum matrices with the carbides and oxides presently studied alone. O.C.

A86-33323
THERMOPHYSICS OF DECOMPOSING MATERIALS [TEPLOFIZIKA RAZLAGAIUSHCHIKHSIA MATERIALOV]
O. F. SHLENSKII, A. G. SHASHKOV, and L. N. AKSENOV Moscow, Energoatomizdat, 1985, 145 p. In Russian. refs

The principal characteristics of heat and mass transfer in various materials used in load-bearing and heat-insulating structural elements of advanced technical equipment, including flight vehicles, are examined. The procedures and equipment used for determining the thermophysical properties of decomposing and thermally stable materials in the temperature range 20-1000 C are described, and principal kinetic and thermal characteristics are presented for the most important classes of materials. Examples of thermal calculations for various structural elements are included. V.L.

N86-22616# Alcan International Ltd., London (England).
THE DEVELOPMENT OF ALUMINUM-LITHIUM ALLOYS FOR AEROSPACE APPLICATIONS
A. J. CORNISH, A. GRAY, W. S. MILLER, and M. A. REYNOLDS *In* ESA Proceedings of 3rd European Symposium on Spacecraft Materials in Space Environment p 195-201 Nov. 1985 refs
Avail: NTIS HC A13/MF A01

The development of aluminum-lithium based alloys is described by considering the reasons for the rapid growth of interest in the alloy type, the property targets sought, the compositions on which the major effort is concentrated, the properties achieved, and manufacturing. The objective is to achieve a 10% reduction in density relative to standard high strength alloys, together with a 10% increase in stiffness, while matching the strength and other service properties associated with the standard alloys. Two aluminum-lithium based alloys are under development to match the service properties of alloys in the 2000 and 7000 series. One alloy is used in different tempers, either to match the properties of the medium strength alloy 2014 T6 or to give a low density replacement for the damage tolerant alloy 2024 T3. The second has a higher strength and matches the properties of 7075 T6. Author (ESA)

N86-22621# Centre National d'Etudes Spatiales, Toulouse (France).
NEW SPACE PAINTS
J. C. GUILLAUMON *In* ESA Proceedings of 3rd European Symposium on Spacecraft Materials in Space Environment p 239-243 Nov. 1985 refs
Avail: NTIS HC A13/MF A01

White conductive paint with low solar absorptance (improvement of PCB-Z) (0.16 to 0.18); black conductive paint with low outgassing (improvement of PU1); white silicone paint with low solar absorptance (0.13); epoxy primer with low outgassing; and white conductive paint for launchers and aircraft were developed. Improvements under study are outlined. Author (ESA)

N86-22642 Pittsburgh Univ., Pa.
INTERACTIONS BETWEEN FLOW, HEAT AND MASS TRANSFER DURING FORMATION OF CARBON-FIBER REINFORCED EPOXY COMPOSITES Ph.D. Thesis
Y. S. WANG 1985 174 p
Avail: Univ. Microfilms Order No. DA852482

Reinforced epoxy composites that contain long carbon fibers have shown strength and durability when used in aircraft secondary structures. The curing process of epoxy composites is complex. The polymerization reaction, heat and mass transfer, and flow have to be analyzed simultaneously. The interaction of cure kinetics, chemo-rheology, heat and mass transfer, and flow consolidation is concerned. The pregelation cure kinetics was described in terms of the overall reaction rate parameters and heat of polymerization using differential scanning calorimeter techniques. Viscosity measurements of the epoxy resin as a function of time at constant temperature were made at Lockheed Company and were combined with the kinetic data. The simultaneous heat and mass transfer was modeled mathematically. The density and thermophysical properties of the curing prepreg such as specific heat and thermal diffusivity were measured. Experiments were done with practical composite, simulated composite and also a macroscopic system to study the flow phenomena. Dissert. Abstr.

N86-22648# Construcciones Aeronauticas S.A., Madrid (Spain).
ADVANCED COMPOSITE STRUCTURES IN COMMERCIAL TRANSPORT AIRCRAFT
J. KOSHORST (Airbus Industrie) Nov. 1984 29 p
(AI/TE3-384/82-ISSUE-2) Avail: NTIS HC A03/MF A01

Design factors which govern the introduction of advanced composite structures on transport aircraft are reviewed. The efforts made in this field of technology must be balanced either through weight saving, manufacturing considerations, or increased structural performance. The A-310 aircraft is used to demonstrate how these objectives are met. Author (ESA)

N86-22651# Massachusetts Inst. of Tech., Cambridge. Dept. of Materials Science and Engineering.
POTENTIAL OF COMPOSITE MATERIALS TO REPLACE CHROMIUM, COBALT AND MANGANESE IN CRITICAL APPLICATIONS
J. CLARK 1985 160 p refs Sponsored by Office of Technology Assessment, Washington, D.C.
(PB86-123965) Avail: NTIS HC A08/MF A01 CSCL 11D

An analysis of the potential for substituting composite materials for critical materials in the jet engine, automotive and oil/gas equipment industries is given. It includes an assessment of the technical, economic and institutional factors contributing to direct and indirect substitution in these industries. GRA

N86-22687*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CERAMIC THERMAL BARRIER COATINGS FOR ELECTRIC UTILITY GAS TURBINE ENGINES
R. A. MILLER 1986 15 p refs Presented at the 3rd Berkeley Conference on Corrosion, Erosion, and Wear of Materials, *Berkeley, Calif., 29-31 Jan. 1986; sponsored by the National* Association of Corrosion Engineers
(NASA-TM-87288; E-2994; NAS 1.15:87288) Avail: NTIS HC A02/MF A01 CSCL 11F

Research and development into thermal barrier coatings for electric utility gas turbine engines is reviewed critically. The type of coating systems developed for aircraft applications are found to be preferred for clear fuel electric utility applications. These coating systems consists of a layer of plasma sprayed zirconia-yttria ceramic over a layer of MCrAly bond coat. They are not recommended for use when molten salts are presented. Efforts to understand coating degradation in dirty environments and to develop corrosion resistant thermal barrier coatings are discussed. Author

N86-22710# Imperial Coll. of Science and Technology, London (England). Tribology Section.
PHOSPHORUS ANTI-WEAR ADDITIVES IN HELICOPTER TRANSMISSIONS Final Report
I. N. LACEY, H. A. SPIKES, and P. B. MACPHERSON Jun. 1985 85 p refs
(Contract MOD(RAE)-A12/1664)
(IC-TS015/85; BR96206) Avail: NTIS HC A05/MF A01

The action on helicopter transmissions of phosphonate ester antiwear additives was studied. It is shown that these additives form thick, polymeric films on rolling and rolling-sliding steel surfaces, and these films are able to greatly increase surface separation above that produced by normal elastohydrodynamic lubrication. Author (ESA)

N86-22713*# Pratt and Whitney Aircraft, East Hartford, Conn. Engineering Div.
THERMAL BARRIER COATING LIFE PREDICTION MODEL DEVELOPMENT Annual Report
K. D. SHEFFLER and J. T. DEMASI Nov. 1985 92 p refs
(Contract NAS3-23944)
(NASA-CR-175087; NAS 1.26:175087; AR-1) Avail: NTIS HC A05/MF A01 CSCL 11G

A methodology was established to predict thermal barrier coating life in an environment simulative of that experienced by gas turbine airfoils. Specifically, work is being conducted to determine failure modes of thermal barrier coatings in the aircraft engine environment. Analytical studies coupled with appropriate physical and mechanical property determinations are being employed to derive coating life prediction model(s) on the important failure mode(s). An initial review of experimental and flight service components indicates that the predominant mode of TBC failure involves thermomechanical spallation of the ceramic coating layer. This ceramic spallation involves the formation of a dominant crack in the ceramic coating parallel to and closely adjacent to the metal-ceramic interface. Initial results from a laboratory test program designed to study the influence of various driving forces such as temperature, thermal cycle frequency, environment, and coating thickness, on ceramic coating spalling life suggest that bond coat oxidation damage at the metal-ceramic interface contributes significantly to thermomechánical cracking in the ceramic layer. Low cycle rate furnace testing in air and in argon clearly shows a dramatic increase of spalling life in the non-oxidizing environments. Author

N86-22724# Suntech, Inc., Marcus Hook, Pa.
TURBINE FUELS FROM TAR SANDS BITUMEN AND HEAVY OIL. PHASE 1: PRELIMINARY PROCESS ANALYSIS Interim Report, 8 Jul. 1983 - 9 Apr. 1984
A. F. TALBOT, V. ELANCHENNY, A. MACRIS, and J. P. SCHWEDOCK 9 Apr. 1985 183 p
(Contract F33615-83-C-2352)
(AD-A161300; AFWAL-TR-85-2013) Avail: NTIS HC A09/MF A01 CSCL 21D

The strategic potential of domestic bitumens and heavy crude oils as substitutes for imported crude rests with their efficient conversion into aviation turbine fuels. In this Phase 1 study, preliminary analyses of several processing schemes have been performed. The comparison included both hydrogen addition and carbon rejection upgrading processes. Projected JP-4 yields, costs, and thermal efficiencies suggest further exploration of the hydrovisbreaking process. For Phase 2, laboratory scale demonstration of the recommended process is proposed. GRA

N86-23663# Royal Aircraft Establishment, Farnborough (England).
FLEXURAL PROPERTIES OF CARBON FIBRE CLOTH/WOOD VENEER LAMINATES
J. H. SEWELL Apr. 1985 23 p
(AD-A161921; RAE-TM-MAT-STR-1055; DRIC-BR-96647) Avail: NTIS HC A02/MF A01 CSCL 11E

Flexural tests have been made on epoxy or phenolic resin bonded hybrid laminates comprising carbon fiber cloth layers on wood veneer cores. Breaking loads and stiffnesses of many of the hybrids exceed those of all carbon fiber cloth laminates of the same weight per unit area of panel. This improvement in flexural properties can be accompanied by a significant decrease in materials costs owing to the replacement of expensive carbon fiber cloth by cheap wood veneers. Significant weight savings may be achieved if carbon fiber laminates are replaced by hybrid laminates having the same flexural breaking strengths or stiffnesses. GRA

N86-23714# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (West Germany).
COMPARISON OF ALUMINUM ALLOYS CONCERNING STRENGTH AND DAMAGE TOLERANCE
L. SCHWARMANN 21 Aug. 1985 21 p refs
(MBB-UT-111/85; REPT-TE-374/0723/85) Avail: NTIS HC A02/MF A01

The static strength, crack growth, and residual strength of high strength aluminum alloys used in aircraft engineering were investigated using approved material data. Alloys having high static strengths show worse crack growth and residual strength behavior compared with alloys having lower static strengths. The 2024-materials show the best crack growth behavior. The 7475-materials show the best residual strength behavior. Heat-treatment influences the crack growth and strength behavior significantly. Product form does not influence crack growth and strength behavior. The casting material A 357 T6 shows nearly the same crack growth behavior as the plate material 2024-T351, but shows worse strength behavior as compared with all other materials considered. Author (ESA)

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ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A86-29870#
A PERIPHERAL INTEGRATED SYSTEM STATUS DISPLAY - FIGURAL GOODNESS OR PROXIMITY EFFECTS?
D. B. BERINGER (Wisconsin, University, Madison) IN: Symposium on Aviation Psychology, 3rd, Columbus, OH, April 22-25, 1985, Proceedings . Columbus, OH, Ohio State University, 1985, p. 183-187.

Certain problems arising in connection with peripheral or secondary displays are examined. Secondary display systems usually require additional visual scanning beyond the primary displays for system control. These secondary devices generally require the diversion of attention from primary displays used for flight control. The occurring lapses in primary task performance may contribute to a degradation in system performance. Such a degradation can be especially threatening in aviation systems used by commercial carriers. Attention is, therefore, given to alternate means of information display and their underlying desired qualities. 'Figural' displays are considered along with integrated displays, the present application used for experimentation, and the experimental examination of the display. The evaluated results suggest that the use of an integrated analog display allowing some shape or figural processing can be beneficial. G.R.

A86-29954
UNIFIED APPROACH FOR MODELLING FATIGUE CRACK GROWTH AND SOME OBSERVATIONS ON BEHAVIOUR UNDER FLIGHT SIMULATION LOADING
K. N. RAJU and R. SUNDER (National Aeronautical Laboratory, Bangalore, India) IN: Advances in fracture research (Fracture 84). Volume 1 . Oxford and New York, Pergamon Press, 1986, p. 57-81. refs

The status of theories on fatigue crack growth under constant and variable amplitude loading is briefly reviewed. A unified model incorporating the concepts of energy balance, damage, and the phenomenon of crack closure is described in detail. The crack growth rate relation derived from the model is found to account for the effects of a number of parameters such as fracture toughness, stress ratio threshold thickness, and non-LEFM conditions. The damage concept used in the model makes it possible to determine the effects of environmental factors on crack growth rates, including rainfall counting to fatigue crack growth. Some problems encountered in extrapolating crack growth test data on the basis of simple laboratory specimens under flight simulation loading to predict crack growth in structures are examined. I.H.

A86-29961
PROBABILISTIC FATIGUE AND FRACTURE DESIGN
A. O. PAYNE (Royal Melbourne Institute of Technology, Australia) IN: Advances in fracture research (Fracture 84). Volume 1 . Oxford and New York, Pergamon Press, 1986, p. 339-376. refs

A probabilistic approach to ultimate load failure and failure analysis under a wear-out process (due to fatigue or corrosion) is discussed. The approach is used to construct a theoretical model of structural behavior which makes it possible to evaluate the risks of ultimate load failure and failure in specific wear-out conditions. The probabilisitc procedure is illustrated by three examples including: (1) safety-by-inspection of a high strength steel aircraft structure with initial defects included; (2) design optimization for a semisubmersible drilling rig subject to corrosion; (3) and preliminary risk analysis for fatigue and fracture of a welded aluminum alloy road tanker. From a consideration of safety standards in various engineering design fields, the optimum probability of failure due to wear out processes should be less than 10 to the -4th p.a., and is insignificant at 10 to the -7th p.a. I.H.

A86-30014
VARIATION OF EFFECTIVE STRESS RANGE RATIO UNDER SIMPLE VARIABLE AMPLITUDE LOADING
S. CHAND and S. B. L. GARG (M. N. R. Engineering College, Allahabad, India) IN: Advances in fracture research (Fracture 84). Volume 3 . Oxford and New York, Pergamon Press, 1986, p. 1711-1718. refs

It is pointed out that in space vehicles and aircraft structures loading conditions in service are often complex. A number of crack propagation experiments involving different load patterns are reported. Attention is given to the experimental procedure, the development of U-models, an intermediate single Peak High Load Cycle (PHLC) in a Constant Amplitude Load (CAL) test, Hi-Lo load sequence tests and decrease in mean load sequence tests, an intermediate multi-PHLC applied in a CAL-test, and a comparison of Crack Growth Rate (CGR) model results with experimental results. G.R.

A86-30019
FATIGUE OF STRUCTURAL MATERIALS AT HIGH-FREQUENCY CYCLE LOADING
V. A. KUZMENKO (AN USSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) IN: Advances in fracture research (Fracture 84). Volume 3 . Oxford and New York, Pergamon Press, 1986, p. 1791-1798. refs

The operating conditions of many devices of modern technology can produce intensive periodic or random vibrations at high sonic or ultrasonic frequencies, taking into account gas turbine blades, and elements in other aircraft components. These vibrations can become the reason for fatigue fracture. On account of the importance of these phenomena, studies have been conducted of high-frequency cyclic loading (HFCL) fatigue and low-frequency cyclic loading (LFCL) fatigue. Attention is given to the cyclic loading frequency effect on the endurance limit of different materials, and the cyclic loading frequency effect on the fatigue crack growth rate. It is found that the difference between the fatigue characteristics due to different loading frequencies contributes to the increase in the safety factor and, consequently, to an enhancement in the component lifetime. G.R.

A86-30027
SHORT CRACK DEVELOPMENT IN MECHANICAL STRUCTURES
J. NEMEC (Ceskoslovenska Akademie Ved, Ustav Teoreticke a Aplikovane Mechaniky, Prague, Czechoslovakia) and J. DREXLER (Vyzkumny a Zkusebni Letecky Ustav, Prague, Czechoslovakia) IN: Advances in fracture research (Fracture 84). Volume 3 . Oxford and New York, Pergamon Press, 1986, p. 1919-1925.

The physical background of short crack development is discussed, taking into account differences between the results provided by theoretical models and experimental findings. Differences between simplified models and real structures are found to be so pronounced that the applicability of both linear fracture mechanics and theoretical fracture mechanics is limited to developed macrocracks. Short crack systems in aircraft turbine disks are considered, giving attention to questions of basic importance in the solution of operational reliability problems, a statistical analysis concerning the problem of finding a representative description of the state of a structure, and a formula providing an acceptable lifetime estimation in the case of a short crack system for airworthiness requirements. G.R.

A86-30034
FRACTOGRAPHIC STUDY OF FATIGUE CRACK KINETICS IN BODIES AND STRUCTURES
I. NEDBAL, J. SIEGL, and J. KUNZ (Ceske Vysoke Uceni Technicke, Prague, Czechoslovakia) IN: Advances in fracture research (Fracture 84). Volume 3 . Oxford and New York, Pergamon Press, 1986, p. 2033-2040. refs

Some quantitative fractographic analysis methods are outlined which can reveal the macroscopic characteristics of fatigue crack growth. Fractographic data related to crack length are transformed into a description of the fatigue process over time. This fractographic reconstruction of the kinetics of fatigue failure can yield information on failure processes in large-scale structures which are so far unavailable by other means. The results that can be obtained are demonstrated using two case studies of fatigue failure in aircraft structures. C.D.

A86-30091
DURABILITY AND DAMAGE-TOLERANCE DESIGN AND ANALYSIS OF TITANIUM AIRFRAME STRUCTURES
J. B. CHANG (Rockwell International Corp., Los Angeles, CA) IN: Advances in fracture research (Fracture 84). Volume 5 . Oxford and New York, Pergamon Press, 1986, p. 3507-3516. refs

Durability and damage-tolerance requirements and analysis methodologies for Ti primary airframe structures of aircraft systems are described. Durability and damage-tolerance assessments are performed with an automated fatigue crack growth analysis computer code CRKGRO. The CRKGRO calculation of crack growth in cyclic-loaded structures, which is based on linear elastic fracture mechanics, is analyzed. The use of Gallagher's (1974) Willenborg retardation model and the Chang acceleration scheme of Chang et al. (1981) to develop a load interaction model is discussed. The Vroman linear approximation method of Chang et al. (1980) is the damage accumulation scheme for the computer program. The procedure for residual strength analysis is studied. The durability analysis methodology which evaluates the economic life of the structural components of an advanced aircraft is examined. An example of the durability and damage-tolerance analyses of the lower cover of a wing carry-through structure is provided. I.F.

A86-30092
FATIGUE CRACK GROWTH IN PATCHED PLATES UNDER CONSTANT AMPLITUDE AND FLIGHT SIMULATION LOADINGS
R. CHANDRA and R. SUNDER (National Aeronautical Laboratory, Bangalore, India) IN: Advances in fracture research (Fracture 84). Volume 5 . Oxford and New York, Pergamon Press, 1986, p. 3523-3531. Research supported by the Aeronautics Research and Development Board. refs

Fatigue crack propagation was studied in aluminium alloy plates reinforced by adhesive bonding a unidirectional carbon fibre epoxy patch across the crack path. The tests were carried out under constant amplitude as well as flight simulation combat aircraft spectrum loading. Comparative tests were also conducted on unpatched plates. The composite patch considerably reduces crack growth rates. The improvement in resistance to fatigue crack growth is more pronounced under spectrum loading conditions. Author

A86-30359
FAST MOTION SIMULATION
F.-X. DOITTAU, J. R. HURIET, and M. TISSOT (Societe Anonyme d'Etudes et Realisations Nucleaires, Limeil-Brevannes, France) IN: 1985 Summer Computer Simulation Conference, Chicago, IL, July 22-24, 1985, Proceedings . San Diego, CA, Society for Computer Simulation, 1985, p. 727-731.

The Sodern Visualization System (SVS) is a high luminous output video projector which modulates the light using Titus light-valves. These light-valves utilize a solid crystal dielectric target (deuterated potassium diacid phosphate) on which the electrical charge density is controlled by a scanned electron beam. The resulting voltage difference between the two crystal sides induces a proportional optical birefringence which is employed to modulate the polarization of light. The main characteristics of the SVS are discussed, and the influence of light-valve parameters and image source is examined. Attention is given to the light-valve parameters, image source characteristics, the image motion ratio, and the moving images displayed using the SVS. G.R.

A86-30500
OPTIMAL SIZING OF COMPOSITE POWER TRANSMISSION SHAFTING
J. W. LIM (Maryland, University, College Park) and M. S. DARLOW (Rensselaer Polytechnic Institute, Troy, NY) American Helicopter Society, Journal (ISSN 0002-8711), vol. 31, Jan. 1986, p. 75-83. refs
(Contract DAAG29-82-K-0093)

The optimal design of composite drive shafting is developed with the goal of minimizing system weight. The study is illustrated with an application to a composite tail rotor drive shaft for advanced helicopters. It is also applicable to the design of composite synchronization drive shafts for helicopters and other composite shafts for aircraft, spacecraft and automobiles. The use and effectiveness of the optimal design procedure are demonstrated with an illustrative example. In the example, an optimized Graphite/Epoxy (G/E) T300/5208 tail rotor drive shaft with a single tube operating supercritically at 6000 RPM reduces system weight by as much as 63.1 percent compared to a conventional aluminum alloy tail rotor drive shaft system. Even constrained to subcritical operation, an optimized G/E (T300/5208) drive shaft with three tubes at 6000 RPM reduces system weight by as much as 38.1 percent. By comparison, simply replacing the five aluminum shaft sections with G/E (T300/5208) composite tubes operating at 5000 RPM results in a system weight reduction of, at best, only 15.3 percent. Author

A86-30743#
CALCULATION OF RECIRCULATING FLOW BEHIND FLAME-HOLDERS
Q. ZENG, Y. SHENG, and Q. ZHOU (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 6, Oct. 1985, p. 495-497. In Chinese, with abstract in English. refs

Adoptability of standard K-epsilon turbulence model for numerical calculation of recirculating flow is discussed. Many computations of recirculating flows behind bluff-bodies used as flame-holders in afterburner of aeroengine have been completed. Blocking-off method to treat the incline walls of the flame-holder gives good results. In isothermal recirculating flows the flame-holder wall is assumed to be isolated. Therefore, it is possible to remove the inactive zone from the calculation domain in programming to save computer time. The computation for a V-shaped flame-holder exhibits an interesting phenomenon that the recirculation zone extends to the cavity of the flame-holder. Author

A86-31123
A STRESS INTENSITY FACTOR SOLUTION DUE TO HOLES AHEAD OF GROWING CRACKS IN THIN SHEET MATERIAL
J. B. YOUNG and P. N. CAMPBELL (Cranfield Institute of Technology, England) Aeronautical Journal (ISSN 0001-9240), vol. 90, Jan. 1986, p. 1-5. refs

The variation of the Crack Stress Intensity Factor (SIF), for two cracks growing from one hole only in an array of holes in an isotropic material under uni-axial tension has been studied. The effect of the fastener hole ahead of the growing crack was found to give an increase in the SIF only when the crack was within about one and a half diameters of the approached hole edge, compared with the level predicted by considering a single central hole in a plate. An equation suitable for inclusion in a crack growth program has been derived from the research results. Author

A86-31187
NEW SYMMETRICAL CONDENSED NODE FOR THREE-DIMENSIONAL SOLUTION OF ELECTROMAGNETIC-WAVE PROBLEMS BY TLM
P. B. JOHNS (Nottingham University, England) Electronics Letters (ISSN 0013-5194), vol. 22, Jan. 30, 1986, p. 162-164. refs

A new three-dimensional symmetrical condensed node for numerical simulation of electromagnetic waves by TLM has been developed. The advantages of the node are described, the scattering matrix is given and the use of the node in an electromagnetic scattering example is shown. Author

A86-31253
AEROSPACE AND ELECTRONIC SYSTEMS - ADVANCED CONCEPTS AND PIONEERING PERSPECTIVES; PROCEEDINGS OF THE SIXTH SYMPOSIUM, DAYTON, OH, NOVEMBER 14, 15, 1984
Symposium sponsored by IEEE. New York, Institute of Electrical and Electronics Engineers, 1984, 116 p. No individual items are abstracted in this volume.

Among the topics discussed are: the PRAM approach to technology transfer; all-electric aircraft development; and electronic enhancements for the combat aircraft cockpit. Consideration is also given to application of AI systems to military aircraft; ECM and ECCM technology; and the history of monolithic ICs. Developments in the USAF Avionics Integrity Program (AVIP) are reviewed, with emphasis given to: preventive measures for electrostatic discharges; corrosion prevention to increase avionics integrity; and criteria for stress screening temperature levels. I.H.

A86-31258
SECTAM XII - PROCEEDINGS OF THE TWELFTH SOUTHEASTERN CONFERENCE ON THEORETICAL AND APPLIED MECHANICS, PINE MOUNTAIN, GA, MAY 10, 11, 1984. VOLUME 1
Auburn, AL, Auburn University, 1984, 615 p. No individual items are abstracted in this volume.

Turbulence-related investigations are discussed, taking into account the formulation of three-dimensional boundary-layer equations for viscid/inviscid interacting flow, a theory for generating turbulent flow, numerical experiments in open-channel turbulence, the application of the K-E turbulence model to a boundary layer solution for flow about a spinning yawed projectile at Mach 3, and the simulation of late transition in plane channel flow. Other topics explored are related to wave propagation, nonlinear structural dynamics, computational methods, geomechanics, continuum mechanics, experimental methods, fluid mechanics, biofluid mechanics, vibrations of plates and shells, composite materials, fracture mechanics, interdisciplinary/applied problems, hydraulics, fluid-structure interaction, solid mechanics, and the theory of shells. Attention is given to an analysis of a superplastically formed and diffusion bonded sandwich panel, the composite repair of a cracked aluminum alloy aircraft structure, and the determination of turbomachinery blade characteristics for vibration analysis. G.R.

A86-31259
SECTAM XII - PROCEEDINGS OF THE TWELFTH SOUTHEASTERN CONFERENCE ON THEORETICAL AND APPLIED MECHANICS, PINE MOUNTAIN, GA, MAY 10, 11, 1984. VOLUME 2
Auburn, AL, Auburn University, 1984, 586 p. No individual items are abstracted in this volume.

Subjects in the area of fluid mechanics are discussed, taking into account heat-up flows of a contained fluid, an analytical solution for natural convection in a vertical oriented porous annulus, the Weissenberg effect generated by a torsionally oscillating rod in a layered medium, a system analysis for a model of bluff body base flow, steady solutions of the shallow water equations, and the subsonic near-wake of an axisymmetric body with a slanted base. Computational methods are considered along with structural vibrations, structural stability, experimental methods, coastal hydrodynamics, dynamical systems, large space structural systems, the hydraulics of sediment transport, localization of deformation, wave propagation, vibrations of plates and shells, composite materials, and design studies. Attention is given to damage tolerance studies in operational aircraft, design verification testing of advanced prototype structures, continuous filament wound grid stiffened composite structures for aircraft fuselages, and Navier-Stokes solutions for two-dimensional subsonic base flow. G.R.

A86-31356
SUPERSONIC INTERFACE INSTABILITIES OF ACCELERATED SURFACES AND JETS
C. L. GARDNER (New York University, NY) Physics of Fluids (ISSN 0031-9171), vol. 29, March 1986, p. 690-695. refs
(Contract DE-AC02-76ER-03077)

The compressible Rayleigh-Taylor instability of a supersonic accelerated contact discontinuity between two gases is studied by numerically solving the two-dimensional Euler equations. The computed solutions exhibit a complicated set of nonlinear waves comprised of spike and bubble bow shocks, terminal shocks within the spike and bubble, Kelvin-Helmholtz rollup of the spike tip, and contact surface waves. The spike appears to attain a finite growth of aspect ratio approximately equal to 2. The propagation of a supersonic slab jet is also studied numerically, in order to compare and contrast the jet wave structure with that of the supersonic accelerated surface. Author

A86-31374
PLASTIC TORSION OF HOLLOW ELEMENTS OF AIRCRAFT [PLASTICHESKOE KRUCHENIE POLYKH ELEMENTOV LETATEL'NYKH APPARATOV]
IU. P. KATAEV Moscow, Izdatel'stvo Mashinostroenie, 1985, 128 p. In Russian. refs

Engineering methods are presented for calculating the plastic torsion parameters of hollow elements of aerodynamic cross-sectional shape whose thickness varies along the contour length. Methods are also presented for calculating the stress-strain state of hollow elements of aircraft under loading and unloading for varying twist angle and force parameters. The discussion also covers automatic control of the torsion of such aircraft components as the spars of helicopter rotor blades and problems related to dynamic plastic torsion. V.L.

A86-31412
A GENERAL CRITERION IN DESIGN [K VOPROSU OB OBSHCHEM KRITERII V PROEKTIROVANII]
IU. A. KOZLOV, V. N. NOSIK, and A. F. PROTSENKO Samoletostroenie - Tekhnika Vozdushnogo Flota (ISSN 0581-4634), no. 51, 1984, p. 31-35. In Russian.

A criterial approach to the design process and to the qualitative evaluation of the designed components is examined with particular reference to aircraft design applications. It is shown that the criterial concept of the development of a design idea and its evaluation at all stages of the development enable a quantitative expression of elements of an interrelated system of criteria and a transition to the general assessment of the quality of the product at each stage. V.L.

A86-31417
A STUDY OF AN ITERATION METHOD FOR THE ANALYSIS OF PLATES WITH PARALLEL STIFFNESS RIBS AS SYSTEMS OF SUPERELEMENTS [ISSLEDOVANIE ITERATSIONNOGO SPOSOBA RASCHETA PLASTIN S PARALLEL'NYMI REBRAMI ZHESTKOSTI KAK SISTEM SUPERELEMENTOV]
IU. P. PETROV and V. K. ZAITSEV Samoletostroenie - Tekhnika Vozdushnogo Flota (ISSN 0581-4634), no. 51, 1984, p. 59-74. In Russian.

A86-31420
A MATHEMATICAL MODEL FOR STRUCTURES CONSISTING OF ELASTIC SHELL SECTIONS CONNECTED BY OPEN GIRDERS [MATHEMATICHESKAIA MODEL' KONSTRUKTSII, SOSTOIASHCHIKH IZ UPRUGIKH OTSEKOV OBOLOCHEK, SOEDINENNYKH OTKRYTYMI FERMAMI]
N. M. KHARUN Samoletostroenie - Tekhnika Vozdushnogo Flota (ISSN 0581-4634), no. 51, 1984, p. 83-88. In Russian.

A method is proposed for developing a mathematical model describing the stress-strain state of structures consisting of thin-walled discretely reinforced shell sections connected by open girders. The model proposed here is based on the theory of composite systems and is particularly relevant to the design of load-bearing aircraft structures. V.L.

A86-31773
FREE VIBRATION CHARACTERISTICS OF PERIODICALLY STIFFENED PANELS WITH DAMPED STRINGERS
B. V. R. GUPTA (Andhra University, Waltair, India), S. NARAYANAN, and N. GANESAN (Indian Institute of Technology, Madras, India) Journal of Sound and Vibration (ISSN 0022-460X), vol. 105, March 8, 1986, p. 351-356.

It is shown that constrained damping treatment on the flanges of the stiffener of a periodic sheet-stringer panel provides less overall damping than unconstrained damping treatment on the flanges. The resonant frequencies are observed to increase. This type of treatment is also shown to give maximum damping for frequencies corresponding to the stringer torsion mode and minimum damping for the stringer bending mode in the plane of symmetry. In all cases, these trends are the same as those found for unconstrained damping treatment by Narayanan, Gupta, and Ganesan (1984). C.D.

A86-31921
RADIO COMMUNICATION BETWEEN MANOEUVRING PLATFORMS
G. W. MILLWARD (British Aerospace, PLC, Dynamics Group, Bristol, England) IN: International Conference on Antennas and Propagation (ICAP 85), 4th, Coventry, England, April 16-19, 1985, Proceedings . London and New York, Institution of Electrical Engineers, 1985, p. 343-347. refs

A method for deriving the probability distribution of the link margin is proposed. The effects of attitude on antenna gain and cross-polarization loss are examined. The relative distribution of energy between the specular and diffuse reflections of the multipath signals is determined by the roughness of the terrain, grazing angle, and transmission frequency. The relation between the absorption coefficient and height, water vapor content, the earth's curvature, and refraction is discussed. Platform height, maneuver, and velocity, which influence multipath propagation and antenna gain, are studied. An example in which the probability distribution of link margin is calculated for a short range ground-to-air system for a single aircraft is provided. I.F.

A86-32314
ADVANCES IN DISPLAY TECHNOLOGY V; PROCEEDINGS OF THE MEETING, LOS ANGELES, CA, JANUARY 24, 25, 1985
E. SCHLAM, ED. (U.S. Army, Electronic Technology and Devices Laboratory, Fort Monmouth, NJ) Meeting sponsored by SPIE - The International Society for Optical Engineering. Bellingham, WA, SPIE - The International Society for Optical Engineering (SPIE Proceedings. Volume 526), 1985, 124 p. For individual items see A86-32315 to A86-32323.
(SPIE-526)

Display human factors, and various advanced display systems, including CRT and projection display systems, electroluminescent displays, and passive displays, are discussed. Papers are presented on the selection of the best visual system, the effects of adaptation and display luminance on CRT symbol recognition time, and minimum color differences required to recognize small objects on a color CRT. Consideration is given to such display systems as a 160 megapixels per second 2000 line display, a full color liquid crystal light valve projector, and a thin film electroluminescent display optimized for cockpit application. Papers on passive displays include those on amorphous silicon thin film transistor-driven liquid crystal displays, a display based on switchable zero-order diffraction grating valves, and a liquid crystal display system for mass audience viewing. I.S.

A86-32318
160 MEGAPIXELS PER SECOND 2000 LINE DISPLAY
J. A. MAYS (Electronic Image Systems, Inc., Xenia, OH) IN: Advances in display technology V; Proceedings of the Meeting, Los Angeles, CA, January 24, 25, 1985 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1985, p. 43-50.

A program to develop a 2048-by-2048 pixel display is described. Key technical limits are identified, and a R&D program to advance the state-of-the-art by constructing a monochrome and color feasibility model display is discussed. The paper will concentrate on the CRTs, the 160-megapixels/sec video circuitry, and the deflection systems developed for the two feasibility model displays. Author

A86-32320
DEVELOPMENT OF A RASTER/STROKE FULL-COLOR TV PROJECTOR FOR SIMULATION
E. F. GENAW (Systems Research Laboratories, Inc., Dayton, OH) IN: Advances in display technology V; Proceedings of the Meeting, Los Angeles, CA, January 24, 25, 1985 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1985, p. 59-66.

Advances in the simulation industry in Computer Image Generation (CIG) systems and the desire to go to very wide fields of view have created a need for advances in display technology. Hybrid CIG, combining sometimes conflicting raster and stroke (calligraphic) technologies, has furthered the need for advancement. This paper describes some of the challenges and solutions encountered in the production of a projector which fulfills these needs. Problems associated with off-axis projection, convergence, and dynamic spot size control are discussed. Author

A86-32321
THIN FILM ELECTROLUMINESCENT (TFEL) DISPLAY OPTIMIZED FOR COCKPIT APPLICATIONS
G. L. VICK, W. G. RUNYAN, R. F. COLTON, R. J. THORKILDSON, and J. S. TRCKA (Rockwell International Corp., Avionics Group, Cedar Rapids, IA) IN: Advances in display technology V; Proceedings of the Meeting, Los Angeles, CA, January 24, 25, 1985 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1985, p. 71-74.

A thin film electroluminescent flat panel display, developed specifically for the aircraft cockpit is described. The film is a sandwich of Mn-doped ZnS between two layers of Y2O3. The features of the electrical drive, and an optical band pass filter are presented, and the problems of increasing light output from the display, reducing reflections, and enhancing contrast are discussed. Performance data on two sample displays are included. I.S.

A86-32603
EFFECT OF RADAR FREQUENCY ON THE DETECTION OF SHAPED (LOW RCS) TARGETS
D. MORAITIS and S. ALLAND (Hughes Aircraft Co., Culver City, CA) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 159-162. refs

The use of shaping to reduce the radar cross-section (RCS) of aircraft and missiles can result in the RCS varying significantly with radar operating frequency. This RCS sensitivity to frequency should be considered when selecting radar frequency and should be accounted for when evaluating radar performance. A detection range increase for shaped (low RCS) targets of a factor of two or greater can be realized for lower frequency radar (e.g., UHF-Band or L-Band) when compared to higher frequency radar (C-Band or X-Band). For low flying (sea skimming) targets, the RCS variation with frequency for shaped (low RCS) targets neutralizes the advantage that higher radar frequencies realize in multipath

propagation resulting in approximately the same detection range across the radar bands from UHF to X-Band. Author

A86-32605
DETECTABILITY OF LOW FLYING TARGETS IN REAL TERRAIN USING A DIFFRACTION MODEL
H. KUSCHEL (Forschungsgesellschaft fuer angewandte Naturwissenschaften, Forschungsinstitut fuer Hochfrequenzphysik, Wachtberg-Werthhoven, West Germany) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 169-174. refs

A method for the evaluation of transhorizon radar ranges in a short distance environment is described. The method is based on detailed terrain structure information using a digital terrain data base and on a multiple knife edge diffraction propagation model. From the results of a number of simulations in the different types of terrain being typical for Central Europe, mean transhorizon radar range curves are obtained, indicating the capability of radar systems to detect targets beyond the horizon. Varying parameters are the radar wavelength, the radar antenna height and the maximum free space radar range, where the latter depends on radiated power, antenna gain, radar cross section, and other parameters. Author

A86-32614
DETECTION AND RECOGNITION OF HAZARDOUS WEATHER CONDITIONS BY PRIMARY SURVEILLANCE RADAR
W. KLEMBOWSKI (Przemyslowy Instytut Telekomunikacji, Warsaw, Poland) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 226-231. refs

The method of radar range prediction for the weather channel incorporated is PSR is presented. The recognition is based on the following assumptions: hazardous objects have height above the zero izotherm level and reflectivity greater than 40 dBZ. Results of weather clutter detection in the weather channel of the L-band Polish PSR AVIA C are given. Author

A86-32618
NEW CFAR-PROCESSOR BASED ON AN ORDERED STATISTIC
H. ROHLING (Telefunken AG, Ulm, West Germany) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 271-275. refs

In the present paper, a CFAR (constant false alarm rate) method is discussed using as the CFAR threshold one single value selected from the so-called ordered statistic. This procedure has some advantages over cell averaging CFAR, especially in cases where more than one target is present within the reference window on which estimation of the local clutter situation is based, or where this reference window is crossing clutter edges. Author

A86-32642
COMPUTATIONALLY SIMPLE ADAPTIVE TRACKING FILTERS BASED ON WEIGHTED AVERAGES
E. THOMAS (Electronics and Radar Development Establishment, Bangalore, India) IN: International Radar Conference, Arlington, VA, May 6-9, 1985, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1985, p. 416-423. refs

A new algorithm for state estimation, based on certain fading-memory weighted averages, is introduced. The state estimates are obtained through linear combinations of the weighted averages. In their basic general forms, the second-order and third-order Weighted Average Filters are equivalent to over-damped alpha-beta and alha-beta-gamma filters, respectively. Different linear combinations of the weighted averages give state estimates with different band-width characteristics simultaneously. This property leads to the decision-directed, multi-level, switching type adaptive filter described. In the swinging type adaptive filter described later, simple maneuver dependent modifications to the weighted averages make the filter continually self-adaptive to changing situations, with optimized parameters. The computational simplicity of this type is very attractive for tracking maneuvering targets in a real-time, multi-target environment. Author

A86-32973#
NONLINEAR MULTIMODE RESPONSE OF CLAMPED RECTANGULAR PLATES TO ACOUSTIC LOADING
C. MEI (Old Dominion University, Norfolk, VA) and D. B. PAUL (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers. Part 2, p. 676-684) AIAA Journal (ISSN 0001-1452), vol. 24, April 1986, p. 643-648. Previously cited in issue 12, p. 1745, Accession no. A83-29879. refs
(Contract AF-AFOSR-80-0107)

A86-32975#
STEP RELAXATION METHOD FOR MODAL TEST IMPLEMENTED WITH FREQUENCY-DOMAIN PREPROCESSING
F. R. VIGNERON and Y. SOUCY (Department of Communications, Communications Research Centre, Ottawa, Canada) AIAA Journal (ISSN 0001-1452), vol. 24, April 1986, p. 657-663. refs

A continuous longeron space mast having several low frequency, closely spaced modes is taken as an illustrative case demonstrating the 'step relaxation' method for modal testing, which encompasses the preprocessing of data in the frequency domain. Although excellent performance was obtainable in the 0-20 Hz range, the method was not successful for modes above 20 Hz. Attention is given to the construction of the measurement-based frequency-response function, and to parameter identification using a complex exponentials method. O.C.

A86-32984*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
TURBULENT BOUNDARY-LAYER WALL PRESSURE FLUCTUATIONS DOWNSTREAM OF A TANDEM LEBU
G. B. BEELER (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 24, April 1986, p. 689-691. refs

An initial measurement of turbulent wall pressure fluctuations downstream of tandem large eddy breakup devices (LEBUs) indicates a significant reduction by comparison with the reference case of a flat plate; the average magnitude of the reduction is 12.5 percent. Peak reduction is at 7-8 kHz, and is of the order of the C(f) reduction due to the tandem LEBUs. These data indicate a secondary benefit derivable from LEBUs, in addition to their skin friction reduction effect. O.C.

A86-33279
COMPARISON OF SOME TIME DOMAIN METHODS FOR STRUCTURAL SYSTEM IDENTIFICATION
J. E. COOPER and J. R. WRIGHT (Queen Mary College, London, England) IN: International Symposium on Aeroelasticity and Structural Dynamics, 2nd, Aachen, West Germany, April 1-3, 1985, Collected Papers . Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, p. 595-604. refs

The modal parameters of a structural system may be identified from test data by a variety of frequency and time domain methods. In this paper three time domain methods, based on the difference equation model relating sampled response and excitation, are considered. The Least Squares, Instrumental Variables and Correlation Fit methods are described and applied to one and two mode simulated data in the presence of input or measurement noise with various noise-to-signal ratios. The results from a number of tests are compared statistically in order to examine the scatter on damping results and whether they are biased. The Correlation Fit method is seen to be the most suitable method for further development. Author

A86-33292
CALCULATION OF STRUCTURAL ELEMENTS OF AIRCRAFT: SANDWICH PLATES AND SHELLS [RASCHETY ELEMENTOV AVIATSIONNYKH KONSTRUKTSII: TREKHSLOINYE PLASTINY I OBOLOCHKI]
A. IA. ALEKSANDROV, ED., R. E. LAMPER, ED., and V. G. SUVERNEV Moscow, Izdatel'stvo Mashinostroenie, 1985, 208 p. In Russian. No individual items are abstracted in this volume.

The papers presented in this volume provide an overview of theoretical and experimental research in the field of sandwich plates and shells, with particular attention given to the stress-strain and stability analyses of sandwich structures under conditions of complex mechanical and thermal loading. Topics discussed include the transverse bending of sandwich beams, the stability of a cylindrical sandwich shell under compression, the effect of nonuniform heating on the stability of cylindrical sandwich shells under compression, and determination of the optimal parameters of sandwich plates and shallow shells with a honeycomb core under longitudinal compression and heating. Papers are also presented on the stability of a sandwich shell in shear and an iteration theory for the bending of essentially nonuniform plates. V.L.

A86-33293
FREE-SURFACE FLOWS [TECHENIIA SO SVOBODNYMI POVERKHNOSTIAMI]
G. V. LOGVINOVICH, V. N. BUIVOL, A. S. DUDKO, S. I. PUTILIN, and IU. R. SHERCHUK Kiev, Izdatel'stvo Naukova Dumka, 1985, 296 p. In Russian. refs

Results of recent theoretical and experimental research related to free-surface flows are reviewed. Topics discussed include potential flows with free boundaries, axisymmetric cavitation in an ideal fluid, flows in a longitudinal gravitational field, and a wing of low aspect ratio near a curved boundary. Attention is also given to some problems related to perturbations in cavitation flows, the effect of the cavitator orientation on the cavern shape, and liquid rotation in vortex funnels. V.L.

A86-33419
IMPINGING JETS
N. S. NOSSEIR (San Diego State University, CA) IN: Encyclopedia of fluid mechanics. Volume 2 . Houston, TX, Gulf Publishing Co., 1986, p. 349-366. refs
(Contract F49620-78-C-0060; N00014-84-K-0373)

The properties of an axisymmetric, subsonic jet impinging on an infinitely large flat plate are discussed. The mechanisms governing the behavior of the jet are explained based on experimental work. The turbulence characteristics of three modules of the jet are considered, namely the free jet, the stagnation flow, and the wall jet modules. Resonance phenomena at high speeds are examined, including feedback, phase lock, and collective interaction. It is shown that far-field noise is generated by two different mechanisms and propagates along two different paths. C.D.

A86-33453#
SHAPE OPTIMIZATION OF AXISYMMETRIC STRUCTURES [OPTIMISATION DE FORME DES STRUCTURES AXISYMETRIQUES]
C. LALLEMAND Lyon, Institut National des Sciences Appliquees, Docteur (3e cycle) Thesis, 1985, 154 p. In French. refs

Using the finite element method, a general algorithm for the shape optimization of axisymmetric structures subjected to nonsymmetric loading (Fourier series expansions) is presented. In this system, the tangential constraint is minimized, and the Lagrangian method is extended to the mathematical optimization of a function, subject to certain limitations. Several improvements are made on the gradient calculation. The system has application to the aerospace field, where mechanical reliability is crucial, and the method is demonstrated for the specific example of a helicopter gearbox. R.R.

N86-22611# Societe Nationale Industrielle Aerospatiale, Saint-Medard-en-Jalles (France). Etablissement d'Aquitaine.
HOLOGRAPHY: THE NONDESTRUCTIVE TESTING OF COMPOSITE STRUCTURES
P. BARBIER and C. LEFLOCH *In* ESA Proceedings of 3rd European Symposium on Spacecraft Materials in Space Environment p 161-165 Nov. 1985 refs
Avail: NTIS HC A13/MF A01

The principle of nondestructive testing by laser holographic interferometry, and the parts to be controled (parts of motor cases in composite materials) are discussed. The test facility, which involves a complex mechanical system, is described and the technical choices are justified. The economic aspects of the technique are outlined. Author (ESA)

N86-22729# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
LA RECHERCHE AEROSPATIALE, BIMONTHLY BULLETIN, NUMBER 1985-1, 224/JANUARY-FEBRUARY
C. SEVESTRE, ed. ESA Oct. 1985 70 p refs Transl. by ONERA into ENGLISH of 'La Recherche Aerospatiale, Bulletin Bimestriel" (Paris, France), No. 1985-1, 224/Jan.-Feb. 1985 (ESA-TT-915) Avail: NTIS HC A04/MF A01; print copy in ENGLISH available at ONERA, Paris FF70; original report in FRENCH available at ONERA, Paris FF70

Aerodynamic methods for designing advanced high-speed propellers; a holography stand for high-definition image recording of transparent or opaque images; numerical analysis of singular stress fields at the free edge of layered composites; structure calculations in cyclic viscoplasticity; aircraft pseudo-noise and noise; and use of a radiance amplifier for visualizing seeded aerodynamic flows are discussed. Author (ESA)

N86-22735# Joint Publications Research Service, Arlington, Va.
CHINA REPORT: SCIENCE AND TECHNOLOGY
28 Jan. 1986 109 p refs Transl. into ENGLISH from various Chinese articles
(JPRS-CST-86-004) Avail: NTIS HC A06/MF A01

Various areas of scientific research in China is reported. The increased use of computers in economic development, information systems and meteorological work is described. Aircraft engine design and testing facilities are briefly discussed. The biological treatment of waste water is another area of discussion.

N86-22914*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AN INTEGRATED DEVELOPMENT FACILITY FOR THE CALIBRATION OF LOW-ENERGY CHARGED PARTICLE FLIGHT INSTRUMENTATION Center Director's Discretionary Fund, Final Report
A. P. BIDDLE and J. M. REYNOLDS Oct. 1985 24 p refs
(NASA-TM-86526; NAS 1.15:86526) Avail: NTIS HC A02/MF A01 CSCL 14B

A system was developed for the calibration and development of thermal ion instrumentation. The system provides an extended beam with usable current rates, approx. 1 pA/sq cm, at beam energies as low as 1 eV, with much higher values available with increasing energy. A tandem electrostatic and variable geometry magnetic mirror configuration within the ion source optimizes the use of the ionizing electrons. The system is integrated under microcomputer control to allow automatic control and monitoring of the beam energy and composition and the mass and angle-dependent response of the instrument under test. The system is pumped by a combination of carbon vane and cryogenic sorption roughing pumps and ion and liquid helium operating pumps. E.A.K.

N86-22947 Department of the Air Force, Washington, D.C.
FUEL PUMP VENT DRAIN SYSTEM Patent
R. L. STANLEY and G. R. HENRY, inventors (to Air Force) 10 Sep. 1985 4 p Supersedes AD-D010870 (AD-D011993; US-PATENT-4,539,809; US-PATENT-APPL-SN-566445; US-PATENT-CLASS-60-39.094)
Avail: US Patent and Trademark Office CSCL 21E

A novel drain system for venting excess fuel from the fuel pump of a jet engine, and particularly the augmenter pump of a jet engine afterburner is described. It comprises a drain line connected at a first end to the vent valve of the fuel pump and at a second end to the main fuel supply line for the engine, for draining the excess fuel from the pump to the main fuel line; a check valve in the drain line near the second end thereof for restricting fuel flow through the drain line in a direction from the first end to the second end; and a vent line having a restriction therein defining an orifice of predetermined size connecting the drain line to an overboard dump port open to ambient. GRA

N86-22985# Rolls-Royce Ltd., Derby (England). Nondestructive Testing Div.
LIMITATIONS OF MANUAL NDT SYSTEMS AND THE NO EYES CONCEPT
R. G. TAYLOR 23 Jul. 1985 9 p
(PNR-90291) Avail: NTIS HC A02/MF A01

Defect tolerant design, particularly of aircraft components, and its links with nondestructive testing (NDT) are discussed. Engineering of the NDT technique, defect detection requirements, and human factors in the inspection cycle are considered.
Author (ESA)

N86-23012# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
AEROELASTIC RESEARCH ON WIND TURBINES Progress Report, 1 Jan. - 1 Jul. 1983 [NEGENDE VOORTGANGSRAPPORT. AERO-ELASTISCH ONDERZOEK AAN WINDTURBINES PERIODE 1 JANUARI TOT 1 JULI 1983]
W. KUIK and W. P. KOPPENS Jun. 1983 5 p refs In DUTCH
(VTH-M-474; PR-9) Avail: NTIS HC A02/MF A01

Results and developments of aeroelastic investigations of tip vane wind turbines are presented. Aerodynamic (transfer) flow pieces were applied in the sharp angles between tip vanes and blades to reduce resistance caused by flow release. Analysis of the power curve shows a flow resistance reduction. Helicopter blades appear not to be optimal aerodynamically. Torsional stress measurements on the blade root show a higher flutter rpm, induced by a reduced aerodynamic load of the tip vane. Programs to predict ground resonances and whirl-flutter of a two bladed rotor on a pylon with symmetric stiffness were developed. The programs are part of a stability program which describes a flexible rotor on a flexible pylon. Author (ESA)

N86-23013# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
MEP: A PROGRAM FOR CROSS SECTION MAGNITUDES OF A MULTICELL WING PROFILE [M.E.P. - EEN PROGRAMMA VOOR DOORSNEDEGROOTHEDEN VAN EEN MEERCELLIG VLEUGELPROFIEL]
P. A. JOOSSE Oct. 1983 49 p refs In DUTCH
(VTH-M-487) Avail: NTIS HC A03/MF A01

Based on undisturbed thin walled multicell closed cross sections, an interactive program for the determination of the center of gravity, stress center, shear center, and torsional stiffness of wind turbine blades was developed. In the case of bending it is assumed that the cross sections stay plane, and stress is proportionate to elasticity (Hookes law). Based on the Saint Venant principle, the shear center was calculated using shear flow caused by cross forces. Wing profiles with a thickness/chord ratio 0.20 were assumed. Magnitudes of a three cell hexagon and a Kevlar NACA 23000 profile for tip vanes were calculated. Author (ESA)

N86-23014# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
AEROELASTIC RESEARCH ON WIND TURBINES Progress Report, 1 Jul. 1983 - 1 Jan. 1984 [TIENDE VOORTGANGSRAPPORT. AERO-ELASTISCH ONDERZOEK AAN WINDTUBINES PERIODE 1 JULI 1983 TOT 1 JANUARI 1984]
W. P. KOPPENS and W. KUIK Jan. 1984 7 p refs In DUTCH
(VTH-M-501; PR-10) Avail: NTIS HC A02/MF A01

Tip vane flow resistance was investigated, replacing blades by pipes. Experiments show resistances on the windward side, leading to malfunctioning of the turbine. A cross flow to which the helicopter wing profile used is sensitive was established. Aeroelastic wind tunnel model experiments were started. The importance of stall flutter at tip vane rotors is shown. From calculations it appears that the stability of the rotor can be increased by the application of flapping hinges in the blade root, giving the generator a rotation direction opposite to the rotor, and placing the rotor behind the pylon. Author (ESA)

N86-23016# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
AEROELASTIC RESEARCH ON WIND TURBINES Progress Report, 1 Jan. - 1 Jul. 1984 [ELFDE VOORTGANGSRAPPORT. AERO-ELASTISCH ONDERZOEK AAN WINDTURBINES. PERIODE 1 JANUARI 1984 TOT 1 JULI 1984]
W. P. KOPPENS and W. KUIK Jun. 1984 9 p refs In DUTCH
(VTH-M-517; PR-11) Avail: NTIS HC A02/MF A01

Results and developments of aeroelastic investigations of tip vane wind turbines are presented. The Liebeck (Kolibrie helicopter) wing profile was replaced by a NACA-23012 and a profile specially developed for tip vanes. The Liebeck profile is sensitive to disturbances (torsion) reducing the power coefficient. Flow resistance experiments show that the resistance is caused by viscous and induced resistances. Power curves of a one-blade rotor with and without tip vane were determined in a wind tunnel. The neglect in aeroelastic literature of the contribution of the dynamic profile curvature in case the angle of attack is used instead of the 3/4 chord point appears not permissible.
Author (ESA)

N86-23749*# National Aeronautics and Space Administration, Washington, D.C.
CHINESE SPACE AND AVIATION INDUSTRIES SCORE MAJOR BREAKTHROUGHS
R. HU Apr. 1986 16 p Transl. into ENGLISH from Xiandai Junshi (Conmilit) (Hong Kong), v. 9, no. 11, 1 Jan. 1986 p 88-91 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-4005)
(NASA-TM-87973; NAS 1.15:87973) Avail: NTIS HC A02/MF A01 CSCL 13H

An overview of the current status of China's aviation and aerospace industries is presented, as well as planned future development and areas of importance for China's future space programs. The development of China's CZ-1, CZ-2 and CZ-3 rocket program is discussed, as well as China's satellite launch capabilities. China's first geostationary communications satellite STW-1 is also mentioned, and further development of the second and third communications satellites to be launched in 1987 are shown. Other developments include a seventh low Earth orbiting photographic reconnaissance satellite, plans for an image transmitting remote sensing satellite to be launched in 1988 to 1990, and other satellite developments. The Chinese-designed Y-10 transport aircraft is discussed, as well as the TU-16 bomber aircraft and the co-production agreement with McDonnell Douglas for the MD-82 passenger aircraft. Author

N86-23752# Southeastern Center for Electrical Engineering Education, Inc., St. Cloud, Fla.
USAF/SCEEE (UNITED STATES AIR FORCE/SOUTHEASTERN CENTER FOR ELECTRICAL ENGINEERING EDUCATION) RESEARCH INITIATION PROGRAM RESEARCH REPORTS, VOLUME 2 Interim Report
W. D. PEELE Mar. 1985 987 p
(Contract F49620-82-C-0035)
(AD-A161908; AFOSR-85-0905TR-VOL-2) Avail: NTIS HC A99/MF A03 CSCL 09C

A partial contents of this USAF/SCEEE report follows: A Study in the Mechanical Characterization of Advanced Composite Laminates; Modeling of Multi-Echelon and Multi-Indenture Items with Limited Repair and Transportation During War Time Emergencies; The Effect of Moderate to High Pitching Rates on the Aerodynamic Performance of a NACA 0015 Airfoil at a Reynolds No. of 100,000; Kinetic Energy Dependence of Ion Polar Molecule Collision Rate Constants by Trajectory Calculations; A Dynamic Resource Allocation Model; Electron Paramagnetic Resonance Study of Defects in III-V Semiconductor; and Effect of the Graph on Comprehension and Long-Term Recalls of the Text: Eye Movements in Reading. GRA

N86-23773# Joint Publications Research Service, Arlington, Va.
JAPAN REPORT: SCIENCE AND TECHNOLOGY
25 Mar. 1986 63 p Transl. into ENGLISH from various Japanese articles
(JPRS-JST-86-007) Avail: NTIS HC A04/MF A01

Progress in Japanese science and technology is reported. Topics discussed include: aerospace sciences, biotechnology, metallurgical industry, and new materials.

N86-23783# Royal Signals and Radar Establishment, Christchurch (England).
AN INVESTIGATION OF SYNTHETIC APERTURE RADAR AUTOFOCUS
I. P. FINLEY and J. W. WOOD Apr. 1985 44 p
(AD-A161912; RSRE-MEMO-3790; DRIC-BR-97350) Avail: NTIS HC A03/MF A01 CSCL 17I

SAR imagery is generated by matched filtering the raw azimuth signal history, assuming uniform straight line motion of the aircraft. Unknown aircraft motions alter the matched filter required for processing. Autofocussing involves determinating from the raw data the appropriate matched filter. In this document the principles of SAR and the requirement for an autofocus system are discussed. Three autofocus methods are investigated: measurement of the power spectrum, contrast maximization, and registration of multilook images. The power spectrum is shown to be unreliable as an autofocus aid. Results of the contract maximisation and registration methods are compared. GRA

N86-23852*# Vigyan Research Associates, Inc., Hampton, Va.
DESIGN OF FUSELAGE SHAPES FOR NATURAL LAMINAR FLOW Final Report
S. S. DODBELE, C. P. VANDAM, and P. M. H. W. VIJGEN (Kansas Univ., Lawrence, Kas.) Washington NASA Mar. 1986 41 p refs
(Contract NAS1-17926)
(NASA-CR-3970; NAS 1.26:3970) Avail: NTIS HC A03/MF A01 CSCL 20D

Recent technological advances in airplane construction techniques and materials allow for the production of aerodynamic surfaces without significant waviness and roughness, permitting long runs of natural laminar flow (NLF). The present research effort seeks to refine and validate computational design tools for use in the design of axisymmetric and nonaxisymmetric natural-laminar-flow bodies. The principal task of the investigation involves fuselage body shaping using a computational design procedure. Analytical methods were refined and exploratory calculations conducted to predict laminar boundary-layer on selected body shapes. Using a low-order surface-singularity aerodynamic analysis program, pressure distribution, boundary-layer development, transition location and drag coefficient have been obtained for a number of body shapes including a representative business-aircraft fuselage. Extensive runs of laminar flow were predicted in regions of favorable pressure gradient on smooth body surfaces. A computational design procedure was developed to obtain a body shape with minimum drag having large extent of NLF. Author

N86-23873# Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.
THREE-DIMENSIONAL FLOW IN COMPRESSORS AND CHANNELS Final Report, 1 Mar. 1979 - 30 Sep. 1985
T. C. ADAMSON, JR. and A. F. MESSITER Nov. 1985 23 p
(Contract N00014-79-C-0285)
(AD-A161858) Avail: NTIS HC A02/MF A01 CSCL 20D

This project was begun in 1979 as a study of three dimensional transonic flows through channels and between compressor blades. In the latter problem, the blades were to be lightly loaded. In 1981, a 3 year study with the broadened goal of studying flow problems in turbomachines was initiated. Specifically, the work was to include a continuation of that in progress on three-dimensional transonic flows through a lightly loaded compressor blade row, supersonic flow over a compression ramp with a turbulent boundary layer, and consideration of transonic flows over heavily loaded blades in a compressor, starting with a two-dimensional cascade and then going to a three-dimensional rotor if the calculations for the cascade was successful. The work in heavily loaded cascades was to build on the experience gained in the lightly loaded case. The work on the compression ramp has application at blade-shroud interfaces in transonic and supersonic flows. Asymptotic methods of analysis have been employed in all the problems to be described, with numerical methods of solution used as needed in some of the inner regions of the flow fields and to illustrate results for example problems. GRA

N86-23874# Naval Research Lab., Washington, D. C.
ENERGY DISSIPATION OF LIQUIDS IN NUTATING SPHERICAL TANKS MEASURED BY A FORCED MOTION-SPIN TABLE Final Report, Jul. 1982 - Jul. 1984
M. F. ZEDD and F. T. DODGE 30 Oct. 1985 29 p
(AD-A161864; NRL-8932) Avail: NTIS HC A03/MF A01 CSCL 21D

A specially constructed drive table is described that can spin and nutate scale-model propellant tanks. Results of typical tests are given in which the liquid resonant frequencies and liquid forces and moments are presented as a function of spin rate, nutation frequency, nutation cone angle, liquid filling level, and liquid viscosity. Also described is an empirical mechanical model composed of a pendulum, a rotor, and dashpots that simulate the liquid resonances (slosh and inertial waves) and the liquid forces and moments. The parameters of the model are determined from the propellant motions. Author (GRA)

N86-23936*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
EXTENDED PARAMETRIC REPRESENTATION OF COMPRESSOR FANS AND TURBINES. VOLUME 1: CMGEN USER'S MANUAL Final Report, Aug. 1982 - Oct. 1983
G. L. CONVERSE and R. G. GIFFIN Mar. 1984 60 p refs 3 Vol.
(Contract NAS3-23055)
(NASA-CR-174645; NAS 1.26:174645; R84AEB378-VOL-1)
Avail: NTIS HC A04/MF A01 CSCL 13I

A modeling technique for fans, boosters, and compressors has been developed which will enable the user to obtain consistent and rapid off-design performance from design point input. The fans and compressors are assumed to be multi-stage machines incorporating front variable stators. The boosters are assumed to be fixed geometry machines. The modeling technique has been incorporated into time sharing program to facilitate its use. Because this report contains a description of the input output data, values of typical inputs, and examples cases, it is suitable as a user's manual. This report is the first of a three volume set describing

the parametric representation of compressors, fans, and turbines. The titles of the three volumes are as follows: (1) Volume 1 CMGEN USER's Manual (Parametric Compressor Generator); (2) Volume 2 PART USER's Manual (parametric Turbine); (3) Volume 3 MODFAN USER's Manual (Parametric Modulating Flow Fan).
Author

N86-23937*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
EXTENDED PARAMETRIC REPRESENTATION OF COMPRESSOR FANS AND TURBINES. VOLUME 2: PART USER'S MANUAL (PARAMETRIC TURBINE) Final Report, Aug. 1982 - Oct. 1983
G. L. COVERSE Mar. 1984 61 p refs 3 Vol.
(Contract NAS3-23055)
(NASA-CR-174646; NAS 1.26:174646; R84AEB379-VOL-2)
Avail: NTIS HC A04/MF A01 CSCL 13I

A turbine modeling technique has been developed which will enable the user to obtain consistent and rapid off-design performance from design point input. This technique is applicable to both axial and radial flow turbine with flow sizes ranging from about one pound per second to several hundred pounds per second. The axial flow turbines may or may not include variable geometry in the first stage nozzle. A user-specified option will also permit the calculation of design point cooling flow levels and corresponding changes in efficiency for the axial flow turbines. The modeling technique has been incorporated into a time-sharing program in order to facilitate its use. Because this report contains a description of the input output data, values of typical inputs, and example cases, it is suitable as a user's manual. This report is the second of a three volume set. The titles of the three volumes are as follows: (1) Volume 1 CMGEN USER's Manual (Parametric Compressor Generator); (2) Volume 2 PART USER's Manual (Parametric Turbine); (3) Volume 3 MODFAN USER's Manual (Parametric Modulation Flow Fan).
Author

N86-23938*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
EXTENDED PARAMETRIC REPRESENTATION OF COMPRESSOR FANS AND TURBINES. VOLUME 3: MODFAN USER'S MANUAL (PARAMETRIC MODULATING FLOW FAN) Final Report, Aug. 1982 - Oct. 1983
G. L. CONVERSE Mar. 1984 50 p refs 3 Vol.
(Contract NAS3-23055)
(NASA-CR-174647; NAS 1.26:174647; R84AEB380-VOL-3)
Avail: NTIS HC A03/MF A01 CSCL 13I

A modeling technique for single stage flow modulating fans or centrifugal compressors has been developed which will enable the user to obtain consistent and rapid off-design performnce from design point input. The fan flow modulation may be obtained by either a VIGV (variable inlet guide vane) or a VPF (variable pitch rotor) option. Only the VIGV option is available for the centrifugal compressor. The modeling technique has been incorporated into a time-sharing program to facilitate its use. Because this report contains a description of the input output data, values of typical inputs, and examples cases, it is suitable as a user's manual. This report is the last of a three volume set describing the parametric representation of compressor fans, and turbines. The titles of the three volumes are as follows: (1) Volume 1 CMGEN USER's Manual (Parametric Compressor Generator); (2) Volume 2 PART USER's Manual (Parametric Turbine); (3) Volume 3 MODFAN USER's Manual (Parametric Modulating Flow Fan).
Author

N86-23971 Cincinnati Univ., Ohio.
INVESTIGATION OF MULTIPLE INPUT FREQUENCY RESPONSE FUNCTION ESTIMATION TECHNIQUES FOR EXPERIMENTAL MODAL ANALYSIS Ph.D. Thesis
R. W. ROST 1985 237 p
Avail: Univ. Microfilms Order No. DA8526568

The accurate measurement of the frequency response function is vital to the estimation of the modal parameters of a system. The use of single input/output theory to formulate the equations for the frequency response function can be replaced by an equivalent theory involving multiple inputs. The results of this approach provide frequency response functions that are comparable to the single input/output case but with an increase in the consistency of modal frequency and damping values estimated from different frequency response functions. The concept of MAC, Modal Assurance Criterion, was expanded to include the possibility of multiple reference data. Numerous tests were conducted to evaluate and prove the techniques presented. The structures range from machine tools, airplanes, automobiles, electric generators, and encompass almost any large structure imaginable.
Dissert. Abstr.

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A86-31225
AN ILL WIND
J. W. WILSON (National Center for Atmospheric Research, Boulder, CO) Natural History (ISSN 0028-0712), vol. 95, March 1986, p. 48-51.

Downbursts which are produced when a rain shower or thunderstorm creates a current of rapidly downward moving air that spreads horizontally in a starburst pattern when it hits the ground are studied. Data from field experiments examining airflow in downbursts with Doppler radar and anemometers reveal that downbursts occur in varying sizes and strengths, and last for an average of 10-20 minutes. It is observed that microbursts are downbursts with diameter of 0.25-2.5 miles and they endanger aircraft. Variations in the intensity of the head wind and airflow over the wings affects the aircraft. The formation processes for cool air masses which cause the downdraft to reach the ground and produce microburst wind shear are examined. An experiment demonstrating the usefulness of wind shear warnings and the need to develop microburst real-time forecast and warning services are discussed.
I.F.

A86-31955#
NOISE OF THE GENERAL AVIATION AIRPLANES INFLUENCE ON ENVIRONMENT OF THE AIRCLUB, AIRFIELDS AND ON CREWS
S. GVOZDENOVIC, D. ZORIC (Beograd, Univerzitet, Belgrade, Yugoslavia), and M. TAUSANOVIC (Jugoslovenski Aerotransport, Belgrade, Yugoslavia) IN: Inter-noise 85; Proceedings of the Fourteenth International Conference on Noise Control Engineering, Munich, West Germany, September 18-20, 1985. Volume 1 . Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz, 1985, p. 307-310.

Noise measurements from general aviation at airport in Yugoslavia, both outside and inside the cockpit, are reported. Measurements were made at 1800 m and at 1000 m from the takeoff starting point, and the results are presented as a function of aircraft type. Noise levels are given for start of engine, taxiing, takeoff, climb, cruise, approach to landing, short final, and braking.
C.D.

A86-31962#
WHAT SHOULD BE KNOWN ON THE ENVIRONMENTAL IMPACT ASSESSMENT FOR A PLANNING AIRPORT
Z. MAEKAWA (Kobe University, Japan) IN: Inter-noise 85; Proceedings of the Fourteenth International Conference on Noise Control Engineering, Munich, West Germany, September 18-20, 1985. Volume 2 . Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz, 1985, p. 871-874. refs

Attention is given to the development status of noise prediction methods applicable to commercial airport operations during the airport planning stage; such prognostications are notably complicated by meteorological effects. Projections are made on the basis of experimental long distance noise propagation data, theoretical calculations of the noise propagation effects of various meteorological conditions, and aircraft noise level measurements obtained to date for operations at Osaka International Airport. O.C.

A86-31963#
A QUIET STOLPORT? CONVINCING THE PUBLIC
J. G. CHARLES and W. STUBBS (Bickerdike Allen Partners, London, England) IN: Inter-noise 85; Proceedings of the Fourteenth International Conference on Noise Control Engineering, Munich, West Germany, September 18-20, 1985. Volume 2 . Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz, 1985, p. 891-894.

Because of the need for efficient air travel between London and other centers, a plan was developed to introduce STOL aircraft services using quiet aircraft at a peninsular site wide enough and long enough for a 762 m STOL runway to be constructed. This paper discusses noise disturbances and the problem of convincing the public that an inland airport can be constructed within 20 min travel time of the city's center. The aircraft which would form the basis of any operation at the STOLport, the De Havilland Dash 7, was brought to the area to carry out a simulated approach and landing so that the public could actually experience the noise it made; noise measurements were made so that a data base for technical evaluations could be formed. In spite of this simulation and detailed data presentation, there was criticism and distrust on the part of the public. At the inquiry, it was stated that the noise and number index was unsuitable as a noise disturbance measure, and that despite present intentions, subsequent development would cause a major environmental problem. It is concluded that even greater clarity is needed on the part of those assessing noise impact so as to avoid spreading doubt and dismay. K.K.

A86-32450
TOMORROW'S WEATHER - NEW ACCURACY IN FORECASTING
G. GRAFF High Technology (ISSN 0277-2981), vol. 6, April 1986, p. 27-35.

Projects designed to enhance the accuracy of routine and long-range forecasts and to guarantee early detection of such hazards as tornadoes and wind shear are presented. The Program for Regional Observing and Forecasting Services (PFOFS) aims to overcome conventional forecasting barriers by covering a limited geographical region and by processing the available data more rapidly. One component of PROFS, the advanced Doppler radar, is incorporated into a weather detection effort called Nexrad, whose purpose is to spot severe storms far earlier than is possible with conventional radar. Tornadoes can be spotted well in advance, as well as wind shear. The weather tracking system McIDAS is discussed together with projects designed to enhance air safety, such as the Airport Weather Observing System and the Airport Surface Observing System. Satellite-borne lasers will be used to monitor upper-air activity, and increased accuracy in long-range forecasting will be provided by the Tropical Oceans and Global Atmosphere project. By the turn of the century, it is predicted that two-week forecasts will have the kind of specificity now associated with two-day forecasts. K.K.

A86-32788*# Michigan Technological Univ., Houghton.
TURBULENCE FOR FLIGHT SIMULATION
G. TREVINO (Michigan Technological University, Houghton) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 348, 349. NASA-supported research. Previously cited in issue 07, p. 1078, Accession no. A86-19738. refs

N86-23159*# Oklahoma Univ., Norman. National Severe Storms Lab.
ANALYSIS OF AIRBORNE DOPPLER LIDAR, DOPPLER RADAR AND TALL TOWER MEASUREMENTS OF ATMOSPHERIC FLOWS IN QUIESCENT AND STORMY WEATHER Contractor Report, 27 Apr. 1982 - 31 Jul. 1985
H. B. BLUESTEIN, R. J. DOVIAK, M. D. EILTS, E. W. MCCAUL, R. RABIN, A. SUNDARA-RAJAN, and D. S. ZRNIC Washington NASA Feb. 1986 178 p refs
(Contract NAS8-34749)
(NASA-CR-3960; NAS 1.26:3960) Avail: NTIS HC A09/MF A01 CSCL 04B

The first experiment to combine airborne Doppler Lidar and ground-based dual Doppler Radar measurements of wind to detail the lower tropospheric flows in quiescent and stormy weather was conducted in central Oklahoma during four days in June-July 1981. Data from these unique remote sensing instruments, coupled with data from conventional in-situ facilities, i.e., 500-m meteorological tower, rawinsonde, and surface based sensors, were analyzed to enhance understanding of wind, waves and turbulence. The purposes of the study were to: (1) compare winds mapped by ground-based dual Doppler radars, airborne Doppler lidar, and anemometers on a tower; (2) compare measured atmospheric boundary layer flow with flows predicted by theoretical models; (3) investigate the kinematic structure of air mass boundaries that precede the development of severe storms; and (4) study the kinematic structure of thunderstorm phenomena (downdrafts, gust fronts, etc.) that produce wind shear and turbulence hazardous to aircraft operations. The report consists of three parts: Part 1, Intercomparison of Wind Data from Airborne Lidar, Ground-Based Radars and Instrumented 444 m Tower; Part 2, The Structure of the Convective Atmospheric Boundary Layer as Revealed by Lidar and Doppler Radars; and Part 3, Doppler Lidar Observations in Thunderstorm Environments. Author

N86-23997# Lockheed Missiles and Space Co., Palo Alto, Calif. Research and Development Div.
NUMERICAL GENERATION OF 3D CURVILINEAR COORDINATE SYSTEMS AND COMPUTATIONAL GRIDS FOR AIRCRAFT CONFIGURATIONS Final Technical Report, May 1982 - Jul. 1984
P. D. THOMAS and A. K. WHITNEY Mar. 1985 22 p
(Contract F49620-82-C-0065)
(AD-A162249; LMSC/F035606; AFOSR-85-1058TR) Avail: NTIS HC A02/MF A01 CSCL 12A

This report describes the progress in research on the properties of the Lockheed 3-D elliptic grid generation procedure and improvement of its capabilities for treating complex geometric features characteristic of aircraft configurations. Two areas of weakness in the original technique relate to the fundamentally important capability for generating curved-surface grids as a necessary prerequisite for generating 3-D space grids. These weaknesses were: (1) difficulties associated with the limitations of Cartesian coordinates for describing convex surfaces; and problems in controlling the orthogonality of the grid near boundaries. The bulk of the first year's research resulted in development of a generalized system of elliptic grid generation equations that allow both the surface and the grid to be described in terms of an arbitrary system of curvilinear coordinates. Research in the second year was concerned primarily with the problem of grid orthogonality near boundaries. Three approaches investigated to improve the control that the user has over the angle at which grid lines intersect the boundaries were: (1) refinement of the original techniques; (2) development of techniques for marching from a given boundary using the angle as an initial condition; and (3) derivation of a

fourth-order system that permits additional boundary conditions on the grid intersection angle. GRA

N86-24090*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STATISTICAL ANALYSIS OF DIRECT-STRIKE LIGHTNING DATA (1980 TO 1982)
L. D. LEE, G. B. FINELLI, M. E. THOMAS, and F. L. PITTS Jan. 1984 30 p refs
(NASA-TP-2252; L-15686; NAS 1.60:2252) Avail: NTIS HC A03/MF A01 CSCL 04B

Electromagnetic measurements are being made during direct lightning strikes by NASA Langley Center using a specially instrumented F-106B aircraft. The research is to aid refinement, characterization, and understanding of the lightning-aircraft interaction process and the lightning hazards to aircraft. Statistical methods are applied to characterize some aspects of the lightning data obtained from 176 strikes to the aircraft. Specific attention is given to the problem of estimating the upper extreme quantiles of the distributions of peak-to-peak values for currents and rates of change in the magnetic and flux densities. A formal treatment via a general location-scale family of models allows the estimation method to be adapted to the realized shapes the distributions. The shapes are examined by probability plotting methods. Author

N86-24091*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THE 1982 DIRECT STRIKE LIGHTNING DATA
M. E. THOMAS and F. L. PITTS Mar. 1983 491 p refs
(NASA-TM-84626; NAS 1.15:84626) Avail: NTIS HC A21/MF A01 CSCL 04B

Wideband waveforms data which were obtained during the 1982 direct-strike lightning tests utilizing the NASA F106-B aircraft specially instrumented for lightning electromagnetic measurements. The aircraft was operated in a thunderstorm environment to elicit strikes to the aircraft during this testing period. Electromagnetic field data were recorded to both attached lightning and free field excitation of the aircraft. E.A.K.

N86-24100# Air Force Geophysics Lab., Hanscom AFB, Mass.
STORM PRECIPITATION AND WIND STRUCTURE DURING AIRCRAFT STRIKE LIGHTNING EVENTS Environmental Research Papers
A. R. BOHNE and A. C. CHMELA 24 May 1985 38 p
(AD-A162338; AFGL-TR-85-0121; AFGL-ERP-917) Avail: NTIS HC A03/MF A01 CSCL 04A

A limited set of in situ aircraft and ground-based radar data acquired during the 1981 and 1982 Joint Agency Turbulence Experiment are used to study the relationship of aircraft lightning strikes to storm precipitation, turbulence severity, and wind shear. The strikes are found to be strongly correlated with vertical drafts, predominantly downdrafts. The strikes were also well correlated with regions of strong turbulence. However, since most strong turbulence episodes were not associated with lightning, use of lightning location methods to locate hazardous turbulence within storms is considered unreliable. The strikes occurred in storm regions having radar reflectivity factor between 25 to 35 dBZ. These regions were generally on the boundaries of the dominant storm precipitation cores. Storm wind shear was frequently high in regions near aircraft strikes. The strong correlations with strong turbulence, downdraft boundaries, and precipitation core boundaries suggest that the strikes occurred in regions of charge separation. GRA

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LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and planetary biology.

A86-33184
INTERACTION BETWEEN CONTROLLING, PLANNING, AND FAULT MANAGING IN COMPLEX MAN-MACHINE SYSTEMS
G. JOHANNSEN (Kassel, Gesamthochschule, West Germany) IN: A bridge between control science and technology. Volume 5 . Oxford and New York, Pergamon Press, 1985, p. 2541-2545. refs

The three main task categories in man-machine systems are controlling, planning, and fault managing which are briefly explained in the paper. Their interaction is illustrated schematically with a block diagram and further outlined using Rasmussen's cognitive levels of behaviour. Two paradigms, namely car driving and aircraft piloting, exemplify the nature of the interaction in more detail, partially based on experimental results. The state-of-the-art in modelling these task categories and their interaction is discussed with an emphasis on qualitative vs. quantitative models using control theory, artificial intelligence techniques, and fuzzy set theory. Model-based support and expert systems are mentioned as an important future application. Author

N86-24215# Navy Personnel Research and Development Center, San Diego, Calif.
DEVELOPMENT OF A COMPUTER-MANAGED READINESS ASSESSMENT SYSTEM Final Report, Jul. 1982 - Sep. 1984
W. F. THODE and P. G. BULETZA Dec. 1985 55 p
(AD-A162931; NPRDC-TR-86-8) Avail: NTIS HC A04/MF A01 CSCL 05I

Readiness of operational units, especially Fleet Air Reconnaissance Squadron TWO (VQ-2), is difficult to assess, particularly during operational cycles when the units are fulfilling their missions. This effort was conducted to develop a readiness training assessment system for VQ-2 to provide accurate, timely, and efficient assessments of the operational readiness of aircrew personnel while maintaining the highest possible state of readiness to perform the squadron's mission. The readiness training system for maintaining readiness and training data for VQ-2 aircrew personnel consists of: (1) a matrix for the EP-3E and the EA-3B aircraft of all the events that affect the readiness of the personnel assigned to the 10 crew positions in the EP-3E and the 5 crew positions in the EA-3B for each of the four VQ-2 mission area; (2) a computer-managed system to enter, process, store, and produce the readiness training manual that contains all VQ-2's references on training and readiness. Author (GRA)

N86-24221# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
AN EXAMINATION OF THE LIFE SUPPORT EQUIPMENT DEVELOPMENT AND ACQUISITION PROCESS M.S. Thesis
J. J. MOYER Sep. 1985 66 p
(AD-A162241; AFIT/GSM/XPX/85S-24) Avail: NTIS HC A04/MF A01 CSCL 15E

The process of life support equipment development and acquisition is examined. This research identified the how the present process works, and the problems of the process. The research was limited to the development and acquisition of life support equipment for tactical aircraft. However, most of the problems and steps of the process are shared by life support equipment programs for other users. The process was determined by referring to applicable regulations and interviewing people involved in the process. Problems were identified during interviews, and by examining the process as a whole. Seven problems are identified, of which five are considered correctable in the current defense acquisition framework. Four of the five problems deal

with the management of the acquisition and development process, and combined indicate the lack of an integrated approach. Solutions were developed from suggestions obtained during the interviews and through qualitative analysis of the problems. An integrated solution is proposed in the recommendations. GRA

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A86-30351
1985 SUMMER COMPUTER SIMULATION CONFERENCE, CHICAGO, IL, JULY 22-24, 1985, PROCEEDINGS
Conference sponsored by the Society for Computer Simulation. San Diego, CA, Society for Computer Simulation, 1985, 791 p. For individual items see A86-30352 to A86-30362.

Simulation methods are discussed, taking into account a microcomputer-based integrated simulation support (MISS) system, a production system analysis language for SLAM simulation modeling, model and program structuring for discrete systems simulation, a simulation language for microcomputers, an interactive continuous-system simulation language, and the concept of a general purpose model description language. Other topics explored are related to computer systems, simulation credibility and validation, physical and engineering sciences, data communication systems, chemical sciences, energy, biomedical simulation, environmental sciences, management and the social sciences, training and research simulators, government simulation/computation activities, CAD/CAM and manufacturing systems, artificial intelligence, simulation of discrete systems, and flight simulation systems. Attention is given to industrial automation, resource planning/scheduling, advanced mathematical techniques in chemical science, and dynamical systems in chemical engineering. G.R.

A86-31252
ALL ABOUT SIMULATORS, 1984; PROCEEDINGS OF THE SIMULATORS CONFERENCE, NORFOLK, VA, APRIL 18-20, 1984
V. AMICO, ED. and A. B. CLYMER, ED. Conference sponsored by the Society for Computer Simulation. La Jolla, CA, Society for Computer Simulation (Simulation Series. Volume 14, No. 1), 1984, 325 p. No individual items are abstracted in this volume.

Aspects of simulator development technology are explored, taking into account finite sets of nonlinear algebraic equations in real time, the numerical solution of differential algebraic equation systems, the design and implementation of a discrete time model for real time digital simulation, the development of a configuration management program for nuclear power plant simulators, and application software documentation standards for generating station simulators. Other subjects discussed are related to training with simulators, the simulator industry and its customers, and simulators for research/development/engineering. Attention is given to an electrical simulator for solving linear and nonlinear partial differential equations with an iterative method for refining approximate solutions, a simulator of an intelligent preprocessing image system, tactical software modeling for flight simulators, high-speed simulation of transients in nuclear power plants, a novel idea for microprocessor based simulation training, and a graduate curriculum for simulation/training professionals. G.R.

A86-31262
CONFERENCE ON DECISION AND CONTROL, 23RD, LAS VEGAS, NV, DECEMBER 12-14, 1984, PROCEEDINGS. VOLUME 3
Conference sponsored by IEEE. New York, Institute of Electrical and Electronics Engineers, 1984, 560 p. No individual items are abstracted in this volume.

Various papers on decision and control in engineering are presented. The general topics considered include: estimation and control; parameter convergence issues in adaptive control; nonlinear systems; control of high-performance robots; networks; aerospace applications; stochastic processes and applications to detection, estimation, and information theory; new directions in theory and applications of distributed parameter systems; control and modeling of stochastic systems; and linear systems. Also addressed are: nonstandard approaches to estimation prediction and control; recent advances in adaptive control; symmetries in physics and control theory; robot path planning and control; decision theory; optimal control; decision and control in operations research; systems governed by PDEs or delay DEs; discrete time and sampled data systems; linear system algorithms. C.D.

A86-31312
SMOOTHING PATCHED GRIDS
D. C. WILSON (Florida, University, Gainesville) Computers and Fluids (ISSN 0045-7930), vol. 14, no. 1, 1986, p. 11-22. refs
(Contract AF-AFOSR-83-0158)

The purpose of this paper is to indicate how smoothing techniques can be utilized in the area of grid generation. The focus of the paper is to show how one global grid can be patched together from a number of smaller ones. The procedure usually takes place in two steps. First, one global grid is patched together from a number of smaller ones, allowing for the possibility that the derivatives along common boundaries may not be continuous. The second step is to then approximate this grid by a smooth one in such a way that the essential structure of each patch is preserved. Author

A86-31656#
WIND SHEAR ESTIMATION BY FREQUENCY-SHAPED OPTIMAL ESTIMATOR
J. A. BOSSI (Washington, University, Seattle) and B. K. KIM Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, Mar.-Apr. 1986, p. 164-168. Research supported by Boeing Commercial Airplane Co. Previously cited in issue 10, p. 1447, Accession no. A84-25452. refs

A86-32079#
GRUMMAN'S REAL TIME COMPUTING SYSTEM FOR AVIONICS TESTING
C. SCHIANO and J. SILBERTO (Grumman Corp., Grumman Data Systems, Calverton, NY) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 12 p.
(AIAA PAPER 86-9732)

The Automated Test System (ATS) presented integrates telemetry formatting, preprocessor, central processing, and display subsystems to yield a real time flight test analysis capability. ATS displays the results of engineering computations, speeds data turnaround, and allows the on-line modification of flight plans. The system monitors limit violations at the test director's console as they occur. The adaptive flight testing mode made possible by ATS has led to test director responses ranging from extreme caution to unprecedented flight envelope expansions. O.C.

A86-32081#
HELICOPTER DATA ACQUISITION AND PROCESSING
D. L. MARSHALL (McDonnell Douglas Helicopter Co., Mesa, AZ) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 9 p.
(AIAA PAPER 86-9734)

The Fixed Base Data System (FBDS) is a modular architecture employing state-of-the-art technology for integrated data retrieval,

flight monitoring, data processing, and analysis of helicopter test data. Modularity is a key feature of the system, allowing future expansion of both hardware and software. The goal of FBDS is to process 100 percent of the data required for safe test progress and at least 80 percent of the total data requirement, through complete documentation in near-real time. Real time operations include limit checking of all parameters, data compression, and fatigue damage identification. O.C.

A86-32130#
MOBILE EXPERIMENTAL LABORATORY (MEL)
R. D. TALMADGE (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p.
(AIAA PAPER 86-9801)

This paper discusses an approach to providing a portable high powered computer system for data collection and processing. This system is designed to be used for field measurements and is built in a van. The purchase and modification of the van are discussed. Also the installation of the computer and other equipment is discussed. Author

A86-32148#
TELEMETRY PROCESSING SYSTEM
D. FANUS (Computer Sciences Corp., Lompoc, CA) AIAA, AHS, CASI, DGLR, IES, ISA, ITEA, SETP, and SFTE, Flight Testing Conference, 3rd, Las Vegas, NV, Apr. 2-4, 1986. 8 p.
(AIAA PAPER 86-9825)

Attention is given to a Telemetry Processing System that accepts PCM and FM/analog data streams from aircraft, space vehicles, or satellite systems at rates of up to 10 Mbits. The data streams are ingested by the telemetry preprocessor and subjected to synchronization, decommutation, time tagging, engineering unit conversion, derivation, and format conversion operations. A large selection of built-in, user-accessible algorithms and computational processes are available in the acquisition software. O.C.

A86-32371
NEW CLASS OF FEATURES FOR PATTERN RECOGNITION AND IMAGE ANALYSIS
W. C. CHOATE (Texas Instruments Computer Science Laboratory, Dallas) IN: Architectures and algorithms for digital image processing II; Proceedings of the Meeting, Los Angeles, CA, January 24, 25, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 179-184.

A class of features, called 'edge features', has been developed and applied to several problems of practical interest in image processing. These features are derived from a vector-valued function of the image called the 'edge spectrum'. The edge spectrum at coordinate (x,y) of the image describes the distribution of edge directions near (x,y). Several applications of edge features are discussed. One is considered in some detail. This application is to identify friendly aircraft descending for landing on an aircraft carrier. Identification is achieved by measuring wingspan - a good discriminant between the A6, A7, E2C and F14 aircraft. For this purpose an edge feature was designed for locating the wing tips in the image. Wingspan was converted to physical dimension using range information and the known parameters of the optical system. Author

A86-33047
ESTIMATION OF THE STATE PARAMETERS OF NONLINEAR DYNAMIC SYSTEMS [OB OTSENKE PARAMETROV SOSTOIANIIA NELINEINYKH DINAMICHESKIKH SISTEM]
V. I. GOLOVATENKO-ABRAMOV Priborostroenie (ISSN 0021-3454), vol. 29, Feb. 1986, p. 25-29. In Russian.

A method is presented for developing algorithms for estimating the state parameters of a nonlinear dynamic system in the case where the measurements and the input signal of the system are related through a nonlinear transformation. The mathematical model examined here is relevant to the problem of estimating the motion parameters of a flight vehicle whose control system uses inertial measuring instruments. V.L.

A86-33127
MINIMAX FREQUENCY DOMAIN OPTIMIZATION OF MULTIVARIABLE LINEAR FEEDBACK SYSTEMS
H. KWAKERNAAK (Twente, Technische Hogeschool, Enschede, Netherlands) IN: A bridge between control science and technology. Volume 1 . Oxford and New York, Pergamon Press, 1985, p. 19-24. refs

The minimax optimization of a linear feedback system sensitivity matrix and complement is generalized to the multivariable case. It is assumed that the plant has equally as many inputs as outputs, and it is noted that the solution is generally nonunique. Using the example of the plant which is constituted by the longitudinal dynamics of the CH-47 helicopter control system, the system is shown to produce realistic designs, and a solution of reduced degree is obtained at a lambda of approximately 4.74047. R.R.

A86-33134
ON THE DEVELOPMENT OF EQUIOBSERVABLE FORMS WITH APPLICATION TO ADAPTIVE CONTROL
H. OHTA (Nagoya University, Japan), M. M. GUPTA, and P. N. NIKIFORUK (Saskatchewan, University, Saskatoon, Canada) IN: A bridge between control science and technology. Volume 1 . Oxford and New York, Pergamon Press, 1985, p. 165-170. refs
(Contract NSERC-A-5625; NSERC-A-1080)

Three types of equiobservable forms are presented for linear time-invariant multivariable systems. These forms are developed using a nonminimal realization of a system and have properties that are useful in the analysis and design of state observation and parameter identification problems. By employing the third form, the state equation can be expressed by using filtered values generated from inputs and outputs in an algebraic form, and a new state observer can be obtained. To illustrate the application of the third form, a multivariable adaptive observer is also discussed. This observer is used to design a two-level adaptive flight controller for the pitch attitude control system of an aircraft. This approach appears to overcome some of the limitations that are inherent in the design of the linear optimal control and conventional adaptive control methods. In particular, the feedback gains of the optimal controller are updated using the estimation provided by the adaptive observer. The first-level of control consists of updated feedforward and optimal controllers. The second-level control is an error servo which provides fine compensation. Extensive simulation studies were carried out and some results are provided for the pitch attitude control of a STOL aircraft under two different flight conditions. Author

N86-23309# Joint Publications Research Service, Arlington, Va.
PROGRAMMABLE HAND CALCULATORS IN AVIATION SPORT
A. ROMANYUK *In its* USSR Report: Cybernetics, Computers and Automation Technology (JPRS-UCC-86-003) p 18-23 20 Mar. 1986 Transl. into ENGLISH from Krylya Rodiny (Moscow, USSR), no. 7, Jul. 1985 p 15-16
Avail: NTIS HC A04/MF A01

This research proposes that the MK-54 programmable hand calculator be used as a computer that calculates the points of participants in glider competitions. The cost of this and similar calculators (MK-56, BZ-34) varies between 50 and 100 rubles. The calculators feature a simple programming system, are easy to use and can muster most of the computational power required. It can execute point calculations in different glider class competitions when draws occur both in speed and distance competitions for any combination of finishers. The set-up time to run the calculations is less than 5 minutes, and the time required to calculate the results of one participant is less than 12 seconds. The program has been used in judging oblast competitions. A simplified flow chart of the algorithm used is presented, and a chart of the addressed registers is given. Author

N86-23321*# Stanford Univ., Calif. Center for Reliable Computing.
DYNAMIC ASSERTION TESTING OF FLIGHT CONTROL SOFTWARE
D. M. ANDREWS, A. MAHMOOD, and E. J. MCCLUSKEY Jul. 1985 25 p refs
(Contract NAG2-246)
(NASA-CR-176715; NAS 1.26:176715; SU-HICSS-19) Avail: NTIS HC A02/MF A01 CSCL 09B

Digital Flight Control System (DFCS) software was used as a test case for assertion testing. The assertions were written and embedded in the code, then errors were inserted (seeded) one at a time and the code executed. Results indicate that assertion testing is an effective and efficient method of detecting errors in flight software. Most errors are eliminate at an earlier stage in the development than before. B.G.

N86-23322*# Stanford Univ., Calif. Center for Reliable Computing.
DYNAMIC ASSERTION TESTING OF FLIGHT CONTROL SOFTWARE
D. M. ANDREWS, A. MAHMOOD, and E. J. MCCLUSKEY Jul. 1985 25 p refs Submitted for publication
(Contract NAG2-246)
(NASA-CR-176712; NAS 1.26:176712) Avail: NTIS HC A02/MF A01 CSCL 09B

Assertions are used to dynamically test fault tolerant flight software. The experiment showed that 87% of typical errors introduced into the program would be detected by assertions. Detailed analysis of the test data showed that the number of assertions needed to detect those errors could be reduced to a minimal set. The analysis also revealed that the most effective assertions tested program parameters that provided greater indirect (collateral) testing of other parameters. Author

N86-23323*# Stanford Univ., Calif. Center for Reliable Computing.
A METHODOLOGY FOR TESTING FAULT-TOLERANT SOFTWARE
D. M. ANDREWS, A. MAHMOOD, and E. J. MCCLUSKEY Nov. 1985 26 p refs
(Contract NAG2-246)
(NASA-CR-176713; NAS 1.26:176713; SU-CRC-TR-85-22; SU-CSL-TN-85-282) Avail: NTIS HC A03/MF A01 CSCL 09B

A methodology for testing fault tolerant software is presented. There are problems associated with testing fault tolerant software because many errors are masked or corrected by voters, limiter, or automatic channel synchronization. This methodology illustrates how the same strategies used for testing fault tolerant hardware can be applied to testing fault tolerant software. For example, one strategy used in testing fault tolerant hardware is to disable the redundancy during testing. A similar testing strategy is proposed for software, namely, to move the major emphasis on testing earlier in the development cycle (before the redundancy is in place) thus reducing the possibility that undetected errors will be masked when limiters and voters are added. Author

N86-23325*# Stanford Univ., Calif. Center for Reliable Computing.
DYNAMIC ASSERTION TESTING OF FLIGHT CONTROL SOFTWARE
D. M. ANDREWS, A. MAHMOOD, and E. J. MCCLUSKEY Aug. 1985 25 p refs
(Contract NAG2-246)
(NASA-CR-176716; NAS 1.26:176716; SU-CRC-TR-85-15; SU-CSL-TN-85-274) Avail: NTIS HC A02/MF A01 CSCL 09B

An experiment in using assertions to dynamically test fault tolerant flight software is described. The experiment showed that 87% of typical errors introduced into the program would be detected by assertions. Detailed analysis of the test data showed that the number of assertions needed to detect those errors could be reduced to a minimal set. The analysis also revealed that the most effective assertions tested program parameters that provided greater indirect (collateral) testing of other parameters. Author

N86-23350*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A COMBINED INTEGRATING AND DIFFERENTIATING MATRIX FORMULATION FOR BOUNDARY VALUE PROBLEMS ON RECTANGULAR DOMAINS Final Report
W. D. LAKIN (Old Dominion Univ.) Mar. 1986 31 p refs Submitted for publication
(Contract NAS1-17070; NAS1-18107)
(NASA-CR-178074; ICASE-86-12; NAS 1.26:178074) Avail: NTIS HC A03/MF A01 CSCL 12A

Integrating and differentiating matrices allow the numerical integration and differential of functions whose values are known at points of a discrete grid. Previous derivations of these matrices were restricted to one dimensional grids or to rectangular grids with uniform spacing in at least one direction. Integrating and differentiating matrices were developed for grids with nonuniform spacing in both directions. The use of these matrices as operators to reformulate boundary value problems on rectangular domains as matrix problems for a finite dimensional solution vector is considered. The method requires nonuniform grids which include near boundary points. An eigenvalue problem for the transverse vibrations of a simply supported rectangular plate is solved to illustrate the method. Author

N86-24233# Spectra Research Systems, Inc., Vandenberg AFB, Calif.
FEASIBILITY STUDY FOR A STATIC AIRCRAFT FLIGHT Final Technical Report, Oct. 1984 - Jun. 1985
C. H. HIGHTOWER 14 Jun. 1985 55 p
(Contract N61339-84-C-0069)
(AD-A163129; SRS0069-0001; NAVTRASYSCEN-85-C-0069)
Avail: NTIS HC A04/MF A01 CSCL 09B

The feasibility of embedding training software in modern flight aircraft to maintain pilot proficiency while parked was investigated. Candidate training scenarios critical to pilot performance were identified. Feasibility was demonstrated based on current and projected capabilities of the AYK-14 mission computers performing the weapons and navigation calculations in the Navy's F/A-18 Hornet. It was shown that the version 6 AYK-14 computer with dual single card processors (SCP's) would provide a suitable host for training software. The F/A-18 avionic and display systems are also shown to support the SAFES (Static Aircraft Flight Environment Simulator) concept. A number of candidate SAFES implementations are defined and one selected for feasibility demonstration remove fastener. Author (GRA)

N86-24277*# Carnegie-Mellon Univ., Pittsburgh, Pa.
FAULT-FREE VALIDATION OF A FAULT-TOLERANT MULTIPROCESSOR: BASELINE EXPERIMENTS AND WORKOAD IMPLEMENTATION
F. FEATHER, D. SIEWIOREK, and Z. SEGALL Apr. 1986 59 p refs
(Contract NAG1-190)
(NASA-CR-178075; NAS 1.26:178075) Avail: NTIS HC A04/MF A01 CSCL 09B

In the future, aircraft employing active control technology must use highly reliable multiprocessors in order to achieve flight safety. Such computers must be experimentally validated before they are deployed. This project outlines a methodology for doing fault-free validation of reliable multiprocessors. The methodology begins with baseline experiments, which test single phenomenon. As experiments progress, tools for performance testing are developed. This report presents the results of interrupt baseline experiments performed on the Fault-Tolerant Multiprocessor (FTMP) at NASA-Langley's AIRLAB. Interrupt-causing excepting conditions were tested, and several were found to have unimplemented interrupt handling software while one had an unimplemented interrupt vector. A synthetic workload model for realtime multiprocessors is then developed as an application level performance analysis tool. Details of the workload implementation

and calibration are presented. Both the experimental methodology and the synthetic workload model are general enough to be applicable to reliable multi-processors besides FTMP. Author

N86-24354# Florida Univ., Gainesville.
APPLICATIONS OF DIFFERENTIAL TOPOLOGY TO GRID GENERATION Final Report, 1 Jun. 1983 - 31 May 1984
D. C. WILSON 25 Nov. 1985 46 p
(Contract AF-AFOSR-0158-83)
(AD-A162834; AFOSR-85-1165TR) Avail: NTIS HC A03/MF A01 CSCL 12A

The purpose of this paper is to indicate how smoothing techniques from Differential Topology can be applied to the area of algebraic grid generation in Computational Fluid Dynamics. The basic method is to patch together one global grid from a number of smaller ones. The smoothing theory allows one to blend the grid from one section into the grid of an adjacent one.
Author (GRA)

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PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A86-31010#
MANEUVERS FOR AIRCRAFT NOISE REDUCTION IN TAKEOFF, CLIMB, AND LANDING APPROACH OPERATIONS [MANIOBRAS PARA LA DILUCION DEL RUIDO AERONAUTICO EN LAS OPERACIONES DE DESPEGUE, SUBIDA Y APROXIMACION AL ATERRIZAJE]
M. CUESTA IAA/Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), Dec. 1985, p. 31-37. In Spanish. refs

The present evaluation of the characteristics and comparative effectiveness of maneuvers undertaken to reduce aircraft noise levels (due primarily to propulsion system acoustical characteristics) to mandated values gives attention to such representative aircraft as the B747, DC-10-30, B756/767, A310, and A320. Detailed results are presented from studies conducted to ascertain the noise levels generated by different reduced power takeoff regimes and steep landing approach descent trajectories. O.C.

A86-31954
INTER-NOISE 85; PROCEEDINGS OF THE FOURTEENTH INTERNATIONAL CONFERENCE ON NOISE CONTROL ENGINEERING, MUNICH, WEST GERMANY, SEPTEMBER 18-20, 1985. VOLUMES 1 & 2
Conference sponsored by the International Institute of Noise Control Engineering and Bundesanstalt fuer Arbeitsschutz. Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz (Schriftenreihe der Bundesanstalt fuer Arbeitsschutz, Tagungsbericht, No. 39), 1985. Vol. 1, 759 p.; vol. 2, 774 p. For individual items see A86-31955 to A86-31966.

Various papers on the problem of noise are presented. The general topics addressed include: sources of noise emission; physical phenomena associated with noise; noise control elements; and the generation, transmission, isolation, and reduction of vibrations. Individual subjects discussed include: regulation and technical standards of noise control; noise-induced health disturbances; principles of machine noise reduction; characteristics and prediction of factory sound propagation; reduction of structure-borne noise; noise prediction and planning; noise emission data of machines and equipment; noise emission from road vehicles; noise from general aviation aircraft; noise emission from jet aircraft during takeoff; damping and acoustical radiation efficiency of carbon fiber-reinforced carbon epoxy plates. C.D.

A86-31957#
NOISE EMISSION FROM JET AIRCRAFT DURING TAKE-OFF ROLL WITH RESPECT TO NOISE EXPOSURE CALCULATIONS
C. SVANE, B. PLOVSING (Danish Acoustical Institute, Lingby, Denmark), and R. HIGGINSON (National Physical Laboratory, Teddington, England) IN: Inter-noise 85; Proceedings of the Fourteenth International Conference on Noise Control Engineering, Munich, West Germany, September 18-20, 1985. Volume 1 . Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz, 1985, p. 315-318. Research sponsored by the European Economic Community, Danish National Agency of Environmental Protection and Danish Directorate of Civil Aviation.

The effect of forward speed on aircraft noise emission during takeoff ground-roll is studied. Preliminary results are reported for noise levels measured along a runway at the Copenhagen Kastrup Airport. The general trends of these findings is that noise levels decrease along the runway and that the effect of forward speed on noise emission is higher for low bypass ratio engines than for high bypass ratio engines. A prediction method suitable for incorporation into computer models for airport noise contours is discussed. C.D.

A86-31959#
AIRCRAFT NOISE - DIFFERENT WAYS TO MONITOR THE NOISE LOAD
G. BEKEBREDE (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) IN: Inter-noise 85; Proceedings of the Fourteenth International Conference on Noise Control Engineering, Munich, West Germany, September 18-20, 1985. Volume 2 . Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz, 1985, p. 775-778.

Measures taken by the Dutch government to reduce aircraft-noise disturbances including the establishment of noise zones in which subsequent building is forbidden, while already existing homes are provided with noise insulation are discussed. To ensure accurate noise monitoring, the following recommendations were made by the NLR: (1) regular noise load calculations, utilizing aircraft noise and performance data, the air traffic mix, and flight route information; (2) flight track monitoring, performed by a computerized Flight Track and Aircraft Noise Monitoring System which identifies all aircraft deviating from the prescribed track (i.e., flying over congested regions); and (3) actual noise monitoring, to guard the noise level at a specific noise-sensitive area in close proximity to the airfield, such as a hospital. K.K.

A86-31960#
CHARACTERISTICS OF BACK-RADIATED DEPARTURE NOISE AT SAN FRANCISCO INTERNATIONAL AIRPORT
A. D. FEENER (San Francisco International Airport, CA) and W. K. CONNOR (Tracor Applied Sciences, Inc., Austin, TX) IN: Inter-noise 85; Proceedings of the Fourteenth International Conference on Noise Control Engineering, Munich, West Germany, September 18-20, 1985. Volume 2 . Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz, 1985, p. 779-782.

In response to community concerns, the San Francisco International Airport initiated a study to determine the characteristics of disturbing noise, investigate the factors involved, and develop abatement procedures and policies. Field data were obtained at three sites (two elevated, one at runway level) with a tape recorder connected directly to the noise-monitoring-terminal microphone preamplifier output (which contains an A-weighing circuit). Two noise events were produced by departing planes, the first corresponding to takeoff roll, the second to climbout. Deck angle change, atmospheric refraction effects, and a decrease in ground attenuation are all contributing factors. A difference in spectral shape was found between the first event at a site situated at runway elevation and all other events. In the latter, greater excess attenuation from atmospheric and ground effects caused a concentration of energy in the low-frequency range. The question of the underestimation of impact by the monitoring system was subsequently addressed, and it was concluded that the noise level

versus time patterns were unusual and call for special considerations in monitoring community noise. K.K.

A86-31961#
NOISE OF MILITARY AIRCRAFT IN THE RANGE OF AIRPORTS AND AT LOW LEVEL FLIGHTS
V. HANS (*Kaiserslautern, Universitaet, West Germany*) IN: Inter-noise 85; Proceedings of the Fourteenth International Conference on Noise Control Engineering, Munich, West Germany, September 18-20, 1985. Volume 2 . Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz, 1985, p. 783-786.

Military airport noise differs from that of civilian airports in its origins, characteristics, and potential effects. While civilian aircraft frequency spectra are characterized by amplitudes ranging from 75 dB(A) to 85 dB(A), military aircraft amplitudes can range from 70 dB(A) to 120 dB(A). The validity of the equivalent continuous sound level (Leq) as a measure of aircraft noise is evaluated, and the distribution of sound level versus time at various distances is indicated schematically for low-flying aircraft. The distribution reaches 75-80 dB(A) at 5 sec, after which the distribution goes to a plateau at 80-90 dB(A) in a period of 5-10 sec. Low level flights exhibit sound levels greater than 95 dB(A). Through an analysis of these distributions, plotted during landing approach and low-level flights, it is concluded that the Leq is a poor measure of aircraft disturbance. K.K.

A86-31964#
COMPARISON OF DIFFERENT AIRCRAFT NOISE EXPOSURE INDICES IN FLIGHT CORRIDORS NEAR AIRPORTS
T. J. MEYER IN: Inter-noise 85; Proceedings of the Fourteenth International Conference on Noise Control Engineering, Munich, West Germany, September 18-20, 1985. Volume 2 . Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz, 1985, p. 1057-1060.

Noise indices based on the integration of exposed sound energy can be readily converted from one to another if the same measure for noise exposure is used. It is noted that dB(A) and PNdB can be converted satisfactorily if the distances and corresponding noise spectra of the noisiest starting and landing aircraft contained in the index are known. Approximations of these conversion relationships must take into account either the noise events of a single flight corridor, or the maximum noise levels of aircraft flying outside the flight corridor. They should be within the limits of noise levels of aircraft flying within the corridor. It is concluded that, before using these approximations, it must be determined whether or not an exact calculation with energy equivalent integration is necessary. K.K.

A86-31965#
THE GERMAN-DUTCH WIND TUNNEL - AN AEROACOUSTICS EXPERIMENTATOR'S DREAM
H. HELLER, W. DOBRZYNSKI, W. SPLETTSTOESSER, and K. SCHULTZ (DFVLR, Institut fuer Entwurfs-Aerodynamik, Brunswick, West Germany) IN: Inter-noise 85; Proceedings of the Fourteenth International Conference on Noise Control Engineering, Munich, West Germany, September 18-20, 1985. Volume 2 . Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz, 1985, p. 1091-1094.

The German-Dutch Wind Tunnel/DNW, when used in the acoustic mode, provides a realistic environment for aeroacoustic testing and high-quality data. Two research projects are discussed: (1) helicopter noise research, which concerns itself with high speed impulsive noise and blade/vortex interaction impulsive noise; and (2) propeller noise research. The data obtained proved to be excellent, and in the case of propeller noise research, such data could not have been obtained through flight tests. K.K.

A86-31966#
PROGRESS TOWARDS INTERNATIONAL STANDARDISATION OF AIRCRAFT NOISE CONTOUR CALCULATIONS
R. F. HIGGINSON (National Physical Laboratory, Teddington, England) IN: Inter-noise 85; Proceedings of the Fourteenth International Conference on Noise Control Engineering, Munich, West Germany, September 18-20, 1985. Volume 2 . Dortmund, West Germany, Bundesanstalt fuer Arbeitsschutz, 1985, p. 1413-1415.

There is a need for standardization in noise contour calculations as evidenced by the fact that there is disagreement between nations, and within nations over the following: (1) the data base of individual aircraft noise and performance information; (2) the model formulas used; and (3) the noise index by which output is expressed. Though none of the current efforts being directed towards standardization are addressing the question of noise indices, three international organizations are making headway, the ECAC, the SAE, and the ICAO. The ECAC has established a format for basic aircraft noise and performance information; the SAE has published a prediction method for lateral attenuation of noise during aircraft takeoff and landing; and the ICAO has developed a method of deriving basic noise data and computing noise contours. K.K.

A86-32312
THE DEVELOPMENT OF DICHROMATED GELATIN FOR HOLOGRAPHIC OPTICAL ELEMENT APPLICATIONS
R. W. EVANS (Pilkington Bros., PLC, Research and Development Laboratories, Ormskirk, England) IN: Applications of holography; Proceedings of the Meeting, Los Angeles, CA, January 21-23, 1985 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1985, p. 302-304.

A practical industrial process has been developed for manufacturing holographic optical elements (HOEs), based on dichromated gelatin. The holograms consist of multilayer gelatin thin films having a fluctuating refractive index. The process of manufacturing the films involves recording light sensitive, dichromated gelatin layers and depositing them on to substrates. The films are in turn exposed to optical interference fringes which are produced using laser light. The pattern of light and dark fringes is recorded in the gelatin and transformed to a modulation of the refractive index by washing and swelling the gelatin in water, followed by rapid dehydration in a propanaol solution. Recent development work on thin films of 4-7 microns and thick films of about 60 microns has extended the diffraction efficiency near maximum for both planar and Bragg hologram types. The application of HOEs to Heads-Up Display systems for aircraft is discussed. I.H.

A86-32778#
FINITE ELEMENT MODELING OF ACOUSTIC SINGULARITIES WITH APPLICATION TO PROPELLER NOISE
W. EVERSMAN (Missouri-Rolla, University, Rolla) and J. E. STECK Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 275-282. Previously cited in issue 01, p. 72, Accession no. A85-10842. refs

A86-32783#
ACOUSTICAL DESIGN ECONOMIC TRADEOFF FOR TRANSPORT AIRCRAFT
A. BENITO (Madrid, Universidad Politecnica, Spain) (International Council of the Aeronautical Sciences, Congress, 14th, Toulouse, France, September 9-14, 1984, Proceedings. Volume 2, p. 1247-1255) Journal of Aircraft (ISSN 0021-8669), vol. 23, April 1986, p. 313-320. Research sponsored by Iberia - Lineas Aereas de Espana. Previously cited in issue 22, p. 3298, Accession no. A84-45068. refs

A86-32963*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PREDICTION OF ADVANCED PROPELLER NOISE IN THE TIME DOMAIN
F. FARASSAT (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 24, April 1986, p. 578-584. Previously cited in issue 01, p. 73, Accession no. A85-10854. refs

N86-22964*# Rockwell International Science Center, Thousand Oaks, Calif.
ULTRASONIC CHARACTERIZATION OF MICROSTRUCTURE IN POWDER METAL ALLOY
B. R. TITTMANN, L. A. AHLBERG, and K. FERTIG *In* NASA. Lewis Research Center Analytical Ultrasonics in Materials Research and Testing p 31-47 Jan. 1986 refs
(Contract W-7405-ENG-82)
Avail: NTIS HC A16/MF A01 CSCL 20A

The ultrasonic wave propagation characteristics were measured for IN-100, a powder metallurgy alloy used for aircraft engine components. This material was as a model system for testing the feasibility of characterizing the microstructure of a variety of inhomogeneous media including powder metals, ceramics, castings and components. The data were obtained for a frequency range from about 2 to 20 MHz and were statistically averaged over numerous volume elements of the samples. Micrographical examination provided size and number distributions for grain and pore structure. The results showed that the predominant source for the ultrasonic attenuation and backscatter was a dense (approx. 100/cubic mm) distribution of small micropores (approx. 10 micron radius). Two samples with different micropore densities were studied in detail to test the feasibility of calculating from observed microstructural parameters the frequency dependence of the microstructural backscatter in the regime for which the wavelength is much larger than the size of the individual scattering centers. Excellent agreement was found between predicted and observed values so as to demonstrate the feasibility of solving the forward problem. The results suggest a way towards the nondestructive detection and characterization of anomalous distributions of micropores when conventional ultrasonic imaging is difficult. The findings are potentially significant toward the application of the early detection of porosity during the materials fabrication process and after manufacturing of potential sites for stress induced void coalescence leading to crack initiation and subsequent failure.
Author

N86-23371*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
FREE JET FEASIBILITY STUDY OF A THERMAL ACOUSTIC SHIELD CONCEPT FOR AST/VCE APPLICATION-DUAL FLOW. COMPREHENSIVE DATA REPORT. VOLUME 1: TEST NOZZLES AND ACOUSTIC DATA
B. A. JANARDAN, J. F. BRAUSCH, and A. O. PRICE Oct. 1984 501 p refs 2 Vol.
(Contract NAS3-22137)
(NASA-CR-174817; NAS 1.26:174817; R84AEB570) Avail: NTIS HC A22/MF A01 CSCL 20A

Acoustic and diagnostic data that were obtained to determine the influence of selected geometric and aerodynamic flow variables of coannular nozzles with thermal acoustic shields are summarized in this comprehensive data report. A total of 136 static and simulated flight acoustic test points were conducted with 9 scale-model nozzles The tested nozzles included baseline (unshielded), 180 deg shielded, and 360 deg shielded dual flow coannular plug configurations. The baseline configurations include a high radius ratio unsuppressed coannular plug nozzle and a coanuular plug nozzle and a coannular plug nozzle with a 20-chute outer stream suppressor. The tests were conducted at nozzle temperatures and pressure typical of operating conditions of variable cycle engine.
Author

N86-23372*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
FREE-JET FEASIBILITY STUDY OF A THERMAL ACOUSTIC SHIELD CONCEPT FOR AST/VCE APPLICATION-DUAL STREAM NOZZLES. COMPREHENSIVE DATA REPORT. VOLUME 2: LASER VELOCIMETER AND SUPPRESSOR. BASE PRESSURE DATA
B. A. JANARDAN, J. F. BRAUSCH, and A. O. PRICE Oct. 1984 234 p 2 Vol.
(Contract NAS3-22137)
(NASA-CR-174818; NAS 1.26:174818; R84AEB570) Avail: NTIS HC A11/MF A01 CSCL 20A

Acoustic and diagnostic data that were obtained to determine the influence of selected geometric and aerodynamic flow variables of coannular nozzles with thermal acoustic shields are summarized in this comprehensive data report. A total of 136 static and simulated flight acoustic test points were conducted with 9 scale-model nozzles. Aerodynamic laser velocimeter measurements were made for four selected plumes. In addition, static pressure data in the chute base region of the suppressor configurations were obtained to assess the influence of the shield stream on the suppressor base drag.
Author

N86-24392*# Bionetics Corp., Hampton, Va.
THE RELATIVE EFFECT OF NOISE AT DIFFERENT TIMES OF DAY: AN ANALYSIS OF EXISTING SURVEY DATA
J. M. FIELDS Washington NASA Apr. 1986 80 p refs
(Contract NAS1-16978; DTFA01-834-10564)
(NASA-CR-3965; NAS 1.26:3965) Avail: NTIS HC A05/MF A01 CSCL 20A

This report examines survey evidence on the relative impact of noise at different times of day and assesses the survey methodology which produces that evidence. Analyses of the regression of overall (24-hour) annoyance on noise levels in different time periods can provide direct estimates of the value of the parameters in human reaction models which are used in environmental noise indices such as LDN and CNEL. In this report these analyses are based on the original computer tapes containing the responses of 22,000 respondents from ten studies of response to noise in residential areas. The estimates derived from these analyses are found to be so inaccurate that they do not provide useful information for policy or scientific purposes. The possibility that the type of questionnaire item could be biasing the estimates of the time-of-day weightings is considered but not supported by the data. Two alternatives to the conventional noise reaction model (adjusted energy model) are considered but not supported by the data.
Author

N86-24393*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
CONSIDERATION OF SOME FACTORS AFFECTING LOW-FREQUENCY FUSELAGE NOISE TRANSMISSION FOR PROPELLER AIRCRAFT
J. S. MIXSON and L. A. ROUSSOS Apr. 1986 28 p refs
(NASA-TP-2552; L-14994; NAS 1.60:2552) Avail: NTIS HC A03/MF A01 CSCL 20A

Possible reasons for disagreement between measured and predicted trends of sidewall noise transmission at low frequency are investigated using simplified analysis methods. An analytical model combining incident plane acoustic waves with an infinite flat panel is used to study the effects of sound incidence angle, plate structural properties, frequency, absorption, and the difference between noise reduction and transmission loss. Analysis shows that these factors have significant effects on noise transmission but they do not account for the differences between measured and predicted trends at low frequencies. An analytical model combining an infinite flat plate with a normally incident acoustic wave having exponentially decaying magnitude along one coordinate is used to study the effect of a localized source distribution such as is associated with propeller noise. Results show that the localization brings the predicted low-frequency trend of noise transmission into better agreement with measured propeller results. This effect is independent of low-frequency stiffness effects

that have been previously reported to be associated with boundary conditions. Author

N86-24394*# DSMA Engineering Corp., Orlando, Fla.
MODIFICATIONS TO THE 4X7 METER TUNNEL FOR ACOUSTIC RESEARCH: ENGINEERING FEASIBILITY STUDY Final Report
Mar. 1986 83 p refs
(Contract NAS1-17892)
(NASA-CR-178079; NAS 1.26:178079; REPT-4054/R128) Avail: NTIS HC A05/MF A01 CSCL 20A

The NASA-Langley Research Center 4 x 7 Meter Low Speed Wind Tunnel is currently being used for low speed aerodynamics, V/STOL aerodynamics and, to a limited extent, rotorcraft noise research. The deficiencies of this wind tunnel for both aerodynamics and aeroacoustics research have been recognized for some time. Modifications to the wind tunnel are being made to improve the test section flow quality and to update the model cart systems. A further modification of the 4 x 7 Meter Wind Tunnel to permit rotorcraft model acoustics research has been proposed. As a precursor to the design of the proposed modifications, NASA is conducted both in-house and contracted studies to define the acoustic environment within the wind tunnel and to provide recommendations or the reduction of the wind tunnel background noise to a level acceptable to acoustics researchers. One of these studies by an acoustics consultant, has produced the primary reference documents that define the wind tunnel noise sources and outline recommended solutions. Author

N86-24457# United Technologies Research Center, East Hartford, Conn.
COMPOSITE INTEGRAL RESPONSE SENSING Final Technical Report, Aug. 1982 - Mar. 1985
J. R. DUNPHY, G. MELTZ, and R. M. ELKOW Sep. 1985 116 p
(Contract F08635-83-C-0287)
(AD-A163136; AD-E801242; UTRC/R85-926546-20; AFATL-TR-85-37) Avail: NTIS HC A06/MF A01 CSCL 20F

The investigation of a new concept for measurement of distributed strain is described. Implementation of the technique utilizes a fiber optic device with twin, coupled cores, a single input and a single output. Multiple wavelength operation of the sensor yields a diagnosis of the waveguide coupling perturbations imposed by mechanical disturbances. A general theory for the device has been derived in the form of an integral equation that relates the sensor core contrast to an arbitrary bending strain or curvature. In many cases of interest the curvature is small and slowly varying. For these conditions theory shows the core crosstalk spectrum is directly related to the Fourier transform of the strain distribution on a cantilevered beam. GRA

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

N86-23491# Politecnico di Torino (Italy). Dept. of Aerospace Engineering.
ACTIVITIES REPORT OF THE DEPARTMENT OF AEROSPACE ENGINEERING Annual Report, 1984
Jul. 1985 35 p refs
Avail: NTIS HC A03/MF A01

Research activities in aeronautics and astronautics; fluid dynamics and propulsion; structures and materials; and systems engineering and management are summarized. Author (ESA)

N86-24579# Department of the Air Force, Washington, D.C.
IMPACT OF RELIABILITY/MAINTAINABILITY (R/M) ON LOGISTICS COSTS FOR USAF AIRCRAFT
A. J. SHERBO and J. LOCHBAUM 20 Sep. 1985 42 p Presented at the 19th Annual Department of Defense Cost Analysis Symposium, Leesburg, Va., 17-20 Sep. 1985
(AD-A162204) Avail: NTIS HC A03/MF A01 CSCL 15E

The purpose of this study is to develop some cost estimating relationships (CERs) that supports the contention that higher R&M results in lower logistics support costs, and can be used in a variety of ways. Our primary need is a methodology that enables us to quantify the impact of R&M changes or levels on existing and new aircraft in terms of logistics support costs. The CERs we are searching for need to be at the weapon system level as opposed to the subsystem or component level. GRA

N86-24580# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
COMPARISON OF QUANTITY VERSUS QUALITY USING PERFORMANCE, RELIABILITY, AND LIFE CYCLE COST DATA. A CASE STUDY OF THE F-15, F-16, AND A-10 AIRCRAFT M.S. Thesis
D. C. MERKER Sep. 1985 100 p
(AD-A162238; AFIT/GSM/LSQ/85S-23) Avail: NTIS HC A05/MF A01 CSCL 14A

The quantity versus quality issue is examined and a cost-effectiveness model designed to aid in evaluating it. This model incorporates mission effectiveness, readiness, and life cycle costs. The research effort was hinged around a case study comparison of the F-15, F-16, and A-10 aircraft. These aircraft were chosen because they represented varying system complexities and were used as surrogates to high, medium, and low complexity respectively. The comparisons made were intended to demonstrate the usefulness of using aircraft effectiveness, readiness and cost data in a mathematical cost-effectiveness model. The methodology followed combined multi-attribute value theory, aircraft readiness data, and aircraft life cycle cost information. The result was a series of cost-effectiveness ratios, and a cost-effectiveness curve which incorporated the three close air support aircraft. The cost-effectiveness curve provided the costs, adjusted by both effectiveness and readiness values.
Author (GRA)

N86-24584# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
AN EVALUATION OF CPRA (COST PERFORMANCE REPORT ANALYSIS) ESTIMATE AT COMPLETION TECHNIQUES BASED UPON AFWAL (AIR FORCE WRIGHT AERONAUTICAL LABORATORIES) COST/SCHEDULE CONTROL SYSTEM CRITERIA DATA M.S. Thesis
J. B. PRICE Sep. 1985 67 p
(AD-A162282; AFIT/GSM/LSY/85S-28) Avail: NTIS HC A04/MF A01 CSCL 14B

This thesis examined techniques used to derive estimates of the cost at completion for various research and development programs. The six methods examined were the methods used in the Cost Performance Report Analysis (CPRA) computer program to calculate estimates at completion. The analysis is based on a linear regression between the cost at completion for each technique available. The techniques were ranked by coefficient of determination and a general linear test was performed to test for equality among the regression lines. The results of this investigation indicate that an estimate at completion based upon weighted cost and schedule indices minimizes the unexplained error (as a percentage of total error) and is thought to be the superior forecaster of costs at completion. The general linear test for equality among the regression lines generated by the different techniques did not indicate the existence of commonality between regression lines. This means that each technique tested provided a unique estimate at completion. GRA

N86-24592# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany).

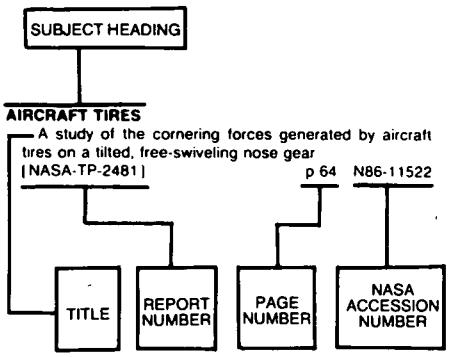
ACTIVITIES REPORT IN AEROSPACE IN WEST GERMANY Annual Report, 1984

Aug. 1984 119 p In GERMAN; ENGLISH summary Original contains color illustrations

(ISSN-0070-3966) Avail: NTIS HC A06/MF A01

Research and development in air traffic management; aircraft technology; turbopropulsion and turbomachinery; nonnuclear energy systems; satellite communication and localization; remote sensing of the Earth; space systems; advanced technologies; and technology transfer are summarized. Project management, organization, DFVLR personnel, and financial development are presented. Author (ESA)

Typical Subject Index Listing



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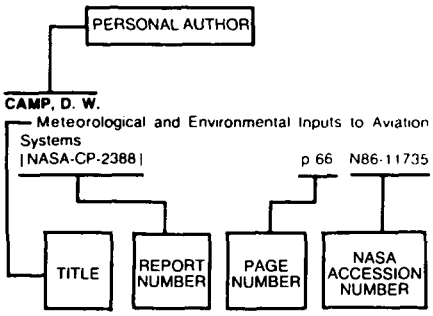
Typical Personal Author Index Listing



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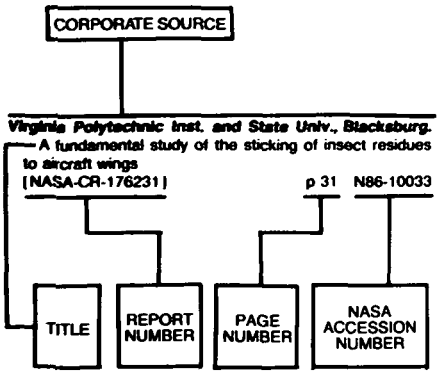

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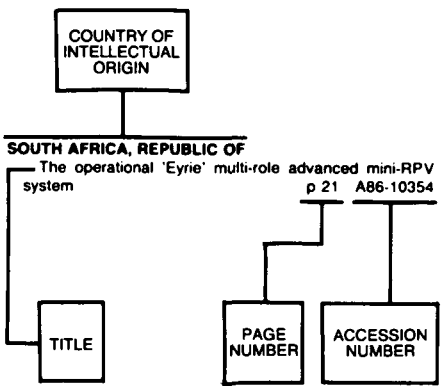

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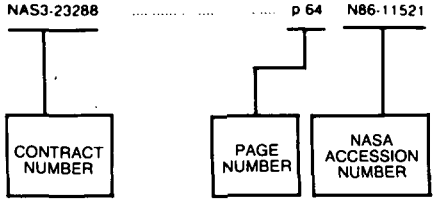

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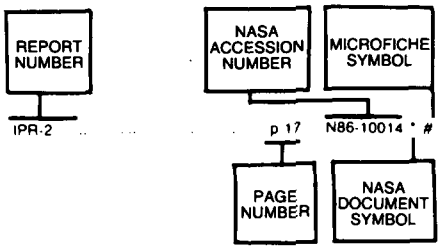

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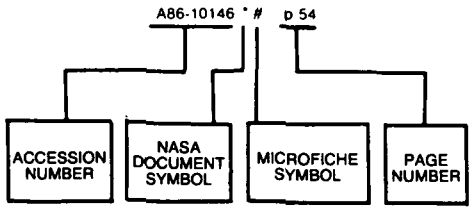

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